PROJECT MANUAL
FOR

HILLSIDE ELEMENTARY SCHOOL
Eagle Point, Oregon

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Book 2

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TABLE OF CONTENTS:

This Project Manual has been organized under the format of the Construction Specifications Institute (CSI). Section numbers are listed merely for identification, and they may not be consecutive. The Contractor shall check the contents of this Manual against the Table of Contents to assure that this volume is complete.

BOOK 1

DIVISION 0 – CONTRACT CONDITIONS

BIDDING REQUIREMENTS

00020 Advertisement for Bid
00100 Instructions to Bidders
00220 Geotechnical Investigation
Geotechnical Report
00410 Bid Form
00415 First-Tier Subcontractor Disclosure Form

CONTRACTING REQUIREMENTS

00500 Agreement for Stipulated Sum
00600 General Conditions
00620 Payment Bond
00622 Performance Bond
00800 Supplementary Conditions
00810 Wage Rates
BOLI Prevailing Wage Rate Handbook
00930 Requests for Interpretation

DIVISION 1 - GENERAL REQUIREMENTS

01050 Construction Staking
01080 Identification Systems
01100 Summary of Work
01230 Alternates and Unit Prices
01290 Application for Payment
01310 Project Coordination
01313 Certificate of Compliance
01314 Certification of No Asbestos
01320 Schedules and Reports
01321 Meetings
01322 Photographs
01330 Shop Drawing, Product Data, & Submittals
01400 Quality Control
01420 Abbreviations and Definitions

01450 Safety
01500 Construction Facilities and Temporary Controls
01615 Delivery, Storage, and Handling
01630 Material Recycling
01640 Substitutions
01710 Cleaning
01731 Cutting and Patching
01750 Warranties and Bonds
01770 Contract Closeout
01781 Record Documents
01782 Operation and Maintenance Data
01900 Utility Location Requirements

DIVISION 2 - SITE CONSTRUCTION

02230 Site Clearing
02300 Earth Moving
02311 Rough Grade
02361 Termite Control
02505 Common Work Results for Utilities
02620 Subdrainage
02630 Storm Utility Drainage Piping
02741 Asphalt Paving
02751 Concrete Paving
02764 Concrete Paving Joint Sealants
02810 Irrigation
02821 Chain Link Fences
02910 Soil Preparation
02920 Sod and Seeding
02930 Planting

DIVISION 3: CONCRETE

03300 Cast-in-Place Concrete
03542 Self Leveling Underlayment

DIVISION 4: MASONRY

04810 Unit Masonry Assemblies

DIVISION 5: METALS

05120 Structural Steel
05500 Metal Fabrications
05521 Pipe and Tube Railings

DIVISION 6: WOOD & PLASTICS

06100 Rough Carpentry
06174 Plywood Web Joists
06176 Metal-Plate-Connected Wood Trusses
06185 Structural Glued-Laminated Timber
06200 Finish Carpentry
06402 Interior Architectural Woodwork

DIVISION 7: THERMAL & MOISTURE PROTECTION

07190 Water Repellants
07210 Building Insulation
07220 Roof Insulation Board
07311 Asphalt Shingles
07412 Metal Wall and Soffit Panels
07620 Sheet Metal Flashing and Trim
07720 Roof Accessories
07841 Through-Penetration Firestop Systems
07920 Joint Sealants

DIVISION 8: DOORS AND WINDOWS

08110 Steel Doors and Frames
08211 Flush Wood Doors
08311 Access Doors
08331 Overhead Coiling Doors
08411 Aluminum-Framed Entrances & Window Systems
08520 Aluminum Windows
08631 Translucent Panel Skylights
08710 Door Hardware
08800 Glazing

DIVISION 9: FINISHES

09255 Gypsum Board Assemblies
09511 Acoustical Panel Ceilings
09651 Resilient Tile Flooring
09652 Sheet Vinyl Floor Coverings
09653 Resilient Wall Base and Accessories
09670 Seamless Troweled Flooring
09680 Carpet – O.F.O.I.
09700 Resilient Gymnasium Flooring – O.F.O.I.
09841 Acoustical Wall Panels
09900 Painting

DIVISION 10: SPECIALTIES

10101 Visual Display Surfaces
10155 Toilet Compartments
10265 Impact-Resistant Wall Protection
10350 Flagpoles
10431 Signage
10520 Fire Protection Specialties
10550 Rapid Entry System
10801 Toilet and Bath Accessories
10990 Miscellaneous Specialties

DIVISION 11: EQUIPMENT

11063 Stage Curtains
11132 Projection Screens
11400 Food Service Equipment
11451 Residential Appliances
11491 Gymnasium Equipment
11500 Outdoor Equipment

DIVISION 12: FURNISHINGS

12491 Horizontal Blinds

DIVISION 13: SPECIAL CONSTRUCTION

None in contract

DIVISION 14: CONVEYING SYSTEMS

None in contract

BOOK 2

DIVISION 15: MECHANICAL

15050 Basic Mechanical Materials and Methods
15060 Pipes and Pipe Fittings
15090 Supports and Anchors
15100 Valves
15240 Mechanical Sound and Vibration Control
15250 Mechanical Insulation
15300 Fire Protection
15350 Gas Distribution
15400 Plumbing
15500 Heating, Ventilating, and Air Conditioning
15550 Heat Generation
15660 Air Cooled Chiller
15850 Air Handling
15880 Air Distribution
15900 Controls
15990 Testing, Adjusting, and Balancing

DIVISION 16: ELECTRICAL

16050 Basic Electrical Materials and Methods
16110 Conduits, Raceways, and Fittings
16120 Conductors
16125 Metal-Clad Cable
16130 Boxes
16140 Wiring Devices
16170 Circuits and Motor Disconnects
16190 Supporting Devices
16195 Electrical Identification
16420 Service Entrance
16425 Switchboards
16450 Grounding
16460 Energy Efficient Dry Type Transformers
16470 Panelboards
16475 Overcurrent Protective Devices
16478 Transient Voltage Surge Suppression
16500 Lighting Fixtures and Lamps
16680 Photovoltaic Array – Performance Specification – O.F.O.I.
16721 Fire Alarm and Detection System
16900 Lighting Controls
16902 Low Voltage Lighting Control Panels

DIVISION 17 - LOW VOLTAGE

17000 Project Overview
17010 Basic Communications Requirements
17030 Administrative Requirements
17080 Project Management and Quality Assurance
17090 Technology Documentation
17100 Cable Plant Overview
17110 Equipment and Telecommunication Room
17120 Entrance Facilities
17130 Interior Communications Pathway
17140 Exterior Communications Pathway
17150 Backbone Cabling Requirements
17160 Horizontal Cabling Requirements
17170 Testing, Identification, and Administration
17750 Paging System

SCHEDULES

Exterior Finish and Color Schedule
Interior Finish and Color Schedule
Door Schedule
Hardware Schedule

END OF TABLE

PART 1 - GENERAL

1.1 DESCRIPTION

A. Requirements Included: Provide all materials, labor and equipment required to install complete mechanical work.

1.2 QUALITY ASSURANCE

A. Codes and Standards: Comply with the provisions of the following codes, standards and specifications, except where more stringent requirements are shown or specified:

1. State of Oregon Structural Specialty Code.
2. State of Oregon Mechanical Specialty Code.
3. State of Oregon Plumbing Specialty Code.
4. State of Oregon Uniform Fire Code.
5. NFPA and other Standards referenced in the above codes.

B. Permits, Licenses, Fees, and Taxes: Obtain and pay for all permits, licenses, fees and taxes applicable to this project as required by law.

C. Drawings: Do not scale drawings for roughing-in measurements, nor use as shop drawings. Make field measurements and prepare shop drawings as required. Coordinate work with shop drawings of other specification divisions.

D. Field Wiring: It is the intent of these specifications that all systems shall be complete and operable. Refer to all drawings and specifications, especially the electrical drawings, to determine voltage, phase, circuit ampacity and number of connections provided. Provide all necessary field wiring and devices from the point of connection indicated on the electrical drawings. All equipment shall be installed in compliance with the Electrical Code and the equipment's UL listing. Bring to the attention of the Architect in writing, all conflicts, incompatibilities, and/or discrepancies prior to bid or as soon as discovered.

1.3 SUBMITTALS

A. Installation Submittals: Clearly indicate which model, size, style, and options are to be provided. Submit all equipment submittals bound together in groups. Deliver all at one time. Arrangement of mechanical equipment has been based on items of specific manufacturer intended as somewhat typical of several makes which may be approved.

B. Wiring Diagrams: Submit complete wiring diagrams showing field-installed wiring and devices for all equipment requiring same.

C. Submittal Review: Comply with the contract documents where deviations, discrepancies, and conflicts between the submittals and the contract documents are discovered prior to or after the review process.

D. Project Record (As-Installed) Drawings:

1. Obtain and pay for reproducible drawings or electronic media from Architect.
2. Keep Drawings clean, undamaged, and up to date.
3. Record and accurately indicate the following:

a. Depths, sizes, and locations of all buried and concealed piping.
b. Locations of all clean-outs.
c. Changes, additions, and revisions due to change orders, obstructions, etc. Eradicate extraneous information.
d. Locations of tracer wire terminal points.

4. Make Drawings available when requested by Architect for review.
5. Submit as part of the required Project Closeout documents. Final submittal will be in the form of reproducible drawings.
6. Quality of entire set of project record drawings to match the quality of the contract documents; quality to be judged by Architect. Computer-aided design drafting (CADD) shall be used to complete project record drawings. Use standards set in contract documents. Note field modifications, all addenda and change order items on project record drawings. If deficiencies are found in either the quality or the accuracy of the drawings, they will be returned unapproved. Additional review of subsequent submissions shall be at the contractor's expense.

E. Operating and Maintenance Manuals: Submit sets of Operating and Maintenance Instructions, including manufacturer's service data, wiring diagrams and parts lists for all major items of equipment, valve charts, balancing data, final control diagrams showing final set points, and any additional equipment added by change order, bound in three-ring, metal-hinged binders organized with index and thumb-tab markers for each classification of equipment or data. Comply with provisions of Sections 01781 and 01782 where applicable to the mechanical work.

F. Instruction Manual: Submit separate Instruction Manual 30 days prior to scheduling the required Instruction Period. Include the following:

1. Description of each system and operational sequences.
2. Seasonal system adjustments.
3. Description and normal settings for time clocks, thermostats, fan and other motor switches, etc.
4. Normal valve settings.
5. Emergency measures upon system failure.
6. Cross reference information furnished by manufacturer in the Operating and Maintenance Manual above.

1.4 STORAGE AND HANDLING

A. Delivery: Deliver to project site with manufacturer's labels intact and legible.

B. Handling: Avoid damage.

C. Storage: Inside protected from weather, dirt and construction dust. Where necessary to store outside, elevate well above grade and enclose with durable, waterproof wrapping.

PART 2 - PRODUCTS

2.1 GENERAL

A. General: Provide all new materials and equipment, identical to apparatus or equipment in successful operation for a minimum of two years. Provide materials of comparable quality omitted here but necessary to complete the work. Maximum allowable variation from stated capacities, minus 5% to plus 10% as approved in each case.

B. Compatibility: Provide products which are compatible with other portions of the work and provide products with the proper or correct power and fuel-burning characteristics, and similar adaptations for the project.

2.2 MOTORS

A. Manufacturers: General Electric, Lincoln, Baldor, Wagner, Westinghouse or accepted substitute. Where selection of motor manufacturer is within Contractor's control (independent of mechanical equipment selection), provide motors produced by a single manufacturer to the greatest extent possible. Where coupled with VFD's, motors shall be so rated.

B. Temperature Rating: Class B insulation, except where otherwise indicated or required for service indicated.

C. Starting Capability: As required for service indicated, but not less than 5 starts per hour.

D. Phases and Current: 1/3 horsepower and smaller capacitor-start, capacitor-run single-phase; 1/2 horsepower and larger, squirrel-cage induction polyphase. Coordinate with actual current characteristics; specified in Division 16 and use no 230/460 voltage motors on 208 voltage power or vice versa.

E. Service Factor: 1.15 for polyphase; 1.35 for single-phase.

F. Construction: General purpose, continuous duty; NEMA design "B", except "C" for high starting torque applications.

G. Frames: For single phase motor sizes NEMA No. 48, except 56 for heavy-duty applications. NEMA "T" frames for 1 horsepower and larger polyphase motors.

H. Bearings: Ball or roller, and design for thrust where applicable; shaft seals and regreasable, except provide permanently sealed where not accessible for greasing. Sleeve-type bearings permitted only where indicated for light-duty fractional horsepower motors.

I. Enclosure Type: Open drip-proof for normal concealed indoor use, guarded where exposed to employees or occupants. Type II for outdoor use, except weather-protected Type I where adequately housed. Totally enclosed where explosion proof motors are required.

J. Overload Protection: Built-in thermal with internal sensing device for stopping motor, and for signaling where indicated on single phase motors.

K. Speed: Not faster than synchronous speeds of 1800 RPM except on some pumps as approved in each case.

L. Efficiency: The manufacturer's highest (premium) efficiency motors tested under procedures recommended by NEMA MG-1 (IEEE Standard 112, Test Method B). Intermittent duty motors, operating less than 6 hours per day, shall comply with EPAct standards. Submit manufacturer's data if motor nameplate does not indicate minimum efficiency. Nominal full load efficiencies for 460 volt, 1800 rpm motors:

HP	Efficiency %
1-1/2	86.5
2	86.5
3	89.5
5	89.5
7-1/2	91.0
10	91.7
15	93.0

20	93.0
25 and larger	93.6

2.3 STARTERS AND SWITCHES

A. Manufacturers: General Electric, ITE, Allen Bradley, Square D, Cutler-Hammer or accepted substitute. Provide starters by same manufacturer throughout project.

B. General: Provide each motor not in a motor control center specified in Division 16 with starter or switch as approved and recommended by manufacturer of motor or equipment of which motor is a part.

C. Starter Characteristics: Type I general purpose enclosure with padlock ears and supports for mounting as indicated. Starter type and size as recommended by motor manufacturer. Use no starter smaller than NEMA Size 1.

D. Manual Switches: Provide on motors 1/3 horsepower and smaller except where automatic control or interlock is indicated. Include pilot light. Provide overload protection where not protected by internal motor overload protection.

E. Magnetic Starters: Provide for 1/2 horsepower and larger motors, and for smaller motors on automatic control or with interlock switch. Include pilot lights, reset, trip-free relay on each phase, and devices for coordination with control system (including 120 volt transformer for control circuit where service exceeds 120 volts). Provide automatic ambient temperature compensation for starter heaters.

2.4 DRIVES

A. Acceptable Manufacturers: Dayton, Gates, Browning.

B. General: "V" section belt drives, multiple as required, sized on 1.5 times installed motor horsepower. Provide variable pitch motor sheaves on all one or two belt drives and standard slide rails or approved means of adjustment for each motor with belt drive. Use standard section belts and no sheave smaller than cataloged industry standard; provide countersunk center on shaft ends to receive speed counter tip.

2.5 SOLID-STATE, VARIABLE-SPEED MOTOR CONTROLLERS

A. General: Controllers listed and labeled as a complete unit and arranged to provide variable speed of a standard NEMA Design B 3-phase induction motor by adjusting output voltage and frequency of controller. Designed and rated by the manufacturer for the type of load (e.g., fans, blowers, and pumps) used and also approved by the manufacturer for the type of connection used between the motor and load (direct connection or power transmission connection).

B. Isolation Transformer (when required by manufacturer): 1-to-1 ratio, with capacity coordinated by the manufacturer for the controller, motor, drive, and load combination.

C. Ratings:

1. Output Ratings: 3-phase, 6 to 60 Hz, with voltage proportional to frequency throughout the voltage range.
2. Starting Torque: 100 percent of rated torque, or as indicated.
3. Speed Regulation: Plus or minus 1 percent.
4. Ambient Temperature: 0° C to 40° C.
5. Efficiency: 95 percent minimum features shall at full load, 60 Hz.

D. Isolated Control Interface: Allow the controller to follow one of the following over an 11:1 speed range:

1. Electrical Signal: 0-10 VDC.
2. Pneumatic Signal: 3 to 15 psig.

E. Internal Adjustability: Provide the following internal adjustment capabilities:

1. Minimum Speed: 5 to 25 percent of maximum RPM.
2. Maximum Speed: 80 to 100 percent of maximum RPM.
3. Acceleration: 2 to 22 seconds.
4. Deceleration: 2 to 22 seconds.
5. Current Limit: 50 to 110 percent of maximum rating.

F. Self-Protection And Reliability Features:

1. Input transient protection by means of surge suppressors.
2. Snubber networks to protect against malfunction due to system voltage transients.
3. Motor Overload Relay: Adjustable and capable of NEMA class 10 performance.
4. Notch filter to prevent operation of the controller-motor-load combination at a natural frequency of the combination.
5. Instantaneous Overcurrent Trip.
6. Loss of Phase Protection.
7. Reverse Phase Protection.
8. Under- and Over-Voltage Trips.
9. Overtemperature Trip.
10. Short Circuit Protection.

G. Automatic Reset/Restart: Attempt 3 restarts after controller fault or on return of power to the system following an interruption and before shutting down for manual reset or fault correction. Provide for restarting during deceleration without damage to the controller, motor, or load.

H. Operation and Maintenance Features: Include:

1. Status Lights: Door-mounted LED indicators to indicate power on, run, overvoltage, line fault, overcurrent, and external fault.
2. Elapsed Time Meter.
3. Panel-Mounted Operator Station: Start-stop and auto-manual selector switches with manual speed control potentiometer.
4. Current-Voltage-Frequency Indicating Devices: Mount meters or digital readout device and selector switch flush in controller door and connect to indicate controller output.
5. Manual Bypass: Magnetic contactor arranged to safely transfer the motor from the controller to the power line, or from the line to the controller while the motor is at zero speed. Include Controller-Off-Bypass selector switch and indicator lights to indicate mode selection.
6. Integral Main Disconnect: Circuit breaker connected to shut down all power to both the controller and the bypass. Interlock breaker with cabinet door.
7. Auxiliary Motor Contactors: Electrically interlocked. One contactor connected between the controller output and the motor, controlled by the controller regulator, and one between the bypass power line and the motor, providing across-the-line starting capability in the bypass mode. Provide motor overload protection under both modes of operation with control logic that allows common start-stop capability in either mode.
8. Isolating Circuit Breaker: Arranged to electrically isolate the variable-speed controller to permit safe trouble-shooting and testing of the controller, both energized and de-energized, while the motor is operating in the bypass mode.

I. Acceptable Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the Work include ABB Power Distribution, Inc. only.

2.5 GUARDS

A. Provide guards in accordance with State Safety Code and OSHA requirements over all rotating equipment including belts, shafts and couplings. Drive guards over belts and sheaves shall include 2-1/2" diameter access opening at shaft ends for speed counter.

2.6 ACCESS PANELS

A. Manufacturers: Inryco/Milcor, Bilco, Elmdor, Karp, Potter-Roemer or accepted substitute. Inryco/Milcor Style DW, K, or M panels as required by construction.

B. Construction: Fire rated in fire rated partitions and ceilings. Screwdriver latches on all access panels.

2.7 MISCELLANEOUS STEEL

A. General: Provide all steel as required for adequate support of all mechanical equipment, standard angle or channel, I or H sections as required by application. Provide shop drawings of supports especially constructed for this project. Adequately cross braced and welded pipe stands may be used for equipment and tank supports. Provide suitable base plates for all stands and anchors for all hanging equipment. Drill or burn support holes in center line of web of structural shapes only, and in only one leg of any one angle, and as far from center of length as possible.

B. Paint: Apply one coat of black Rustoleum primer to shop fabricated items before delivery to job; other painting as specified herein.

2.8 IDENTIFICATION MARKERS

A. Pipe Markers:

1. Adhesive pipe markers of width, letter size and background color conforming to ANSI A13.1.
2. Acceptable Manufacturers: Brady B946 with arrow banding tape or similar Seaton, Zeston, MSI.

B. Duct Markers:

1. Adhesive duct markers 2¼”x14” with black text indicating contents on white background with directional flow arrow.
2. Acceptable Manufacturers: Brady B946 or similar Seaton, Zeston, MSI.

B. Nameplates:

1. Engraved nameplates, 1/16" thick, laminated 2-ply plastic, bottom ply white, outer ply black, letters formed by exposing bottom ply.
2. Size: 2" by 4" nameplates with 1/4" high letters.

C. Valve Tags:

1. 2" diameter, 18-gauge polished brass tags with 3/16" chain hole and 1/4" high stamped, black-filled service designation.

2. Acceptable Manufacturers: Seaton, Brady, MSI.

2.9 CONCRETE FOR MECHANICAL WORK

A. Classes and Applications: Provide strength classes with the following cement content and water/cement ratios for the indicated applications and similar required applications:

1. 4000 psi Class: 565 pounds cement/yard (6.0 sacks); 0.57 water/cement ratio. Provide 4000 Class for tanks, vaults, beam-type foundations and similar structures.
2. 3000 psi Class: 500 pounds cement/yard (5.25 sacks); 0.68 water/cement ratio. Provide 3000 Class for miscellaneous underground structural concrete, reinforced encasement, block type foundations (with smallest dimension at least 0.2 times largest dimension), curbs, pads, inertia blocks (unframed type), and similar structural support work.
3. 2500 psi Class: 450 pounds cement/yard (4.75 sacks); 0.75 water/cement ratio. Provide 2500 Class for plain encasement, thrust blocks, filling steel-framed units, and similar work.
4. Rough Grouting Class: 565 pounds cement/yard (6.0 sacks): 0.75 water-cement ratio; adjust aggregate sizes to facilitate placement. Use for rough grouting, not for setting equipment bases.
5. Backfill Class (Lean Concrete): 375 pounds cement/yard (4.0 sacks); 0.87 water/cement ratio. Use for backfiring where excavations are extended below point of support for mechanical work.

2.10 PENETRATION FIRE STOPPING

A. Through-penetration fire stopping system tested and listed by Underwriters Laboratories. 3M, Metacaulk, SpecSeal, or approved.

B. Select system for proper application based on wall construction, type of penetrating item, wall rating, etc.

PART 3 - EXECUTION

3.1 LAYOUT AND COORDINATION

A. Site Examination: Before starting work, carefully examine site and all contract Drawings. Become thoroughly familiar with conditions governing work on this project. Verify all indicated elevations, building measurements, roughing-in dimensions and equipment locations before proceeding with any of the work.

B. Utility Locations: The location of all utilities, wires, conduits, pipes, ducts, or other service facilities are shown in a general way only on the Drawings and are taken from existing public records. Ascertain whether any additional facilities other than those shown on the plans may be present and determine the exact location and elevations of all utilities prior to commencing installation.

C. Sleeves, Inserts, Cast-in-Place Work: Provide sleeves, inserts, anchoring devices, cast-in-place work, etc. which must be set in concrete sequenced at the proper time for the project schedule.

D. Coordination:

1. Where the work must be sequenced and positioned with precision in order to fit into the available space, prepare accurate scale shop drawings showing the actual physical

dimensions required for the installation and submit prior to purchase-fabrication-installation of any of the elements involved in the coordination.

2. Cooperate with other trades in furnishing material and information for sleeves, bucks, chases, mountings, backing, foundations and wiring required for installation of mechanical items.
3. Coordinate all work with other trades and determine in advance where interfacing of the mechanical work and other work are required to be connected together. Provide all materials and equipment to make those connections. Submit shop drawings showing required connections where special conditions exist.

E. Discrepancies: Report immediately any error, conflict or discrepancy in Plans, Specifications and/or existing conditions. Do not proceed with any questionable items of work until clarification of same has been made. Should rearrangement or re-routing of ducts or piping be necessary, provide for approval the simplest layout possible for that particular portion of the work.

F. Drawings are diagrammatic and do not show all offsets, bends, elbows, etc., which may be required for proper installation of work. Such work shall be verified at building site. Provide additional bends and offsets as required to complete work at no additional cost. Right is reserved to make reasonable changes in outlet locations prior to roughing-in at no additional cost.

3.2 EQUIPMENT REMOVAL

A. All removed mechanical equipment is the property of the Contractor unless indicated otherwise. Disconnect and remove all such equipment from the project property. Cap all piping in walls, below floors, and/or above ceilings in finished rooms.

B. Disable electrical circuits by disconnection of both ends and make safe with wire nuts or other approved methods. Remove wire and conduit to concealed locations.

C. Reused Equipment: Reconnect piping, wiring and/or controls to restore original equipment functions unless indicated otherwise.

3.3 MECHANICAL EQUIPMENT WIRING

A. Provide all mechanical equipment motors, automatic temperature, limit, float and similar control devices required, with wiring complete from power source indicated on Electrical Drawings.

B. Provide properly rated motor overload and undervoltage protection and all manual or automatic motor operating devices for all mechanical equipment.

C. Equipment and systems shown on the Drawings and/or specified, are based upon requirements of specific manufacturers which are intended as somewhat typical of several makes which may be approved. Provide all field wiring and/or devices necessary for a complete and operable system including controls for the actual selected equipment/system.

D. Provide all starters for mechanical motors not included in the motor control center. Review Electrical Specifications and Drawings to determine which mechanical motor starters will be provided under the Electrical Specification Sections and provide all others.

3.4 INSTALLATION

A. Locating and Positioning Equipment: Observe all Codes, Regulations and good common practice in locating and installing mechanical equipment and material so that completed

installation presents the least possible hazard. Maintain adequate clearances for repair and service to all equipment and comply with Code requirements.

B. Arrangement: Arrange ductwork and piping parallel with primary lines of the building construction, and with a minimum of 7' overhead clearance in all areas where possible. Unless indicated otherwise, conceal all piping and ductwork. Locate operating and control equipment properly to provide easy access, and arrange entire mechanical work with adequate access for operation and maintenance. Give right-of-way to piping which must slope for drainage. Set all equipment level or as recommended by manufacturer. Under no conditions shall beams, girders, footings or columns be cut for mechanical items. Casting of pipes into concrete is prohibited unless so shown on Drawings.

C. Anchorage: Support, anchor and/or brace mechanical equipment, piping and ductwork to resist displacement due to seismic action. Refer to Section 15090.

D. Drip Pans: Provide drip pans under all domestic hot water heaters and all above ceiling in-line pumps and cooling coils. Locate pan immediately below piping and equipment, and extend a minimum of 6" on each side and lengthwise 18" beyond equipment being protected. Fabricate pans 2" deep, of reinforced sheet metal (20 gauge copper or 20 gauge steel with 2 ounces zinc finish hot dipped after fabrication) with rolled edges and soldered or welded seams. Provide 3/4" copper drainage piping, properly discharged to over floor drain or as shown on the Drawings. Comply with Mechanical Code Section 307 for overflow protection and pipe sizing.

E. Access Panels: Provide access panels with proper backing reinforcement for all equipment, fire and smoke dampers, dielectric unions and valves requiring service and installed above ceilings, behind walls, or in furring, complete with correct frame for type of building construction involved. Exact size, number and location of access panels are not necessarily shown on Drawings. Use no panel smaller than 12" by 12" for simple manual access or smaller than 16" x 20" where personnel must pass through.

F. Adjusting: Adjust and calibrate all automatic mechanical equipment, mixing valves, flush valves, float devices, etc. Adjust flow rates at each piece of equipment or fixture.

G. Building Vapor Barrier: Wherever the building insulation vapor barrier is penetrated by mechanical piping, hangers, conduits, ductwork, etc., provide clear self-adhesive tape recommended by the insulation manufacturer around the penetrations.

H. Mechanical System Identification:

1. Piping System: Indicate each pipe system by its generic name (abbreviated) as shown/scheduled/specified; except vent and drainage piping. Comply with ANSI A13.1 for marker locations, letter sizes, and colors. Include arrows to show direction of flow and "Electric Traced" signs to identify heat cable wrapped piping. Locate pipe labels in accessible areas as follows:
   a. Near each valve, meter, gauge, or control device.
   b. Near equipment such as pumps, heat exchangers, chillers, boilers, etc.
   c. At piping branch connections.
   d. At penetrations (each side) of walls, ceilings, and floors.
   e. At access panels and doors.
   f. At 25 foot maximum intervals. Provide a minimum of 1 label above each room where lift out ceiling is installed. Reduce intervals in congested areas such as mechanical rooms.
2. Duct System: Identify each duct system including arrow showing direction of flow. Do not label gas vents or chimneys. Do not install labels on flexible ducts. Locate duct labels as follows:
   a. At connections to fans, air handlers, furnaces, and coils.

b. At branch connections and wall, floor, and ceiling penetrations.
c. At 25 foot maximum intervals. Provide a minimum of 1 label above each room where lift out ceiling is installed. Reduce intervals in congested areas such as mechanical rooms.
d. Label access doors to fire and/or smoke dampers as such.

3. Valve Identification: Tag all valves with brass disc and chain. Prepare valve charts indicating valve number, size, location, function and normal position. Use no duplicate numbers in Plumbing and Heating systems. Mount glazed frames containing one set of valve charts in the building as directed.
4. Equipment: Provide engraved plastic-laminate signs at locations of major equipment such as air handlers, furnaces, HVAC units, pumps, etc. Identify equipment in field same as on drawings. Permanently mount in an appropriate and effective location.
5. Operation Tags: Where needed for proper and adequate information on operation and maintenance of mechanical systems, provide tags of plasticized card stock, either pre-printed or hand printed to convey the message; example: "DO NOT CLOSE THIS VALVE EXCEPT WHEN THE PUMP IS OFF."

I. Concrete Work: Coordinate with other work, particularly other concrete work and accessories. Comply with applicable provisions of Section 03310 for mechanical work concrete, including formwork, reinforcement, mix design, materials (use mix designs and materials accepted for Division 3 work where possible), admixtures, accessories, (including waterstops), placing of wet concrete, finishing, curing, protecting, testing, submittals and other requirements of the concrete work.

3.5 PROTECTION

A. Protect all work and materials against loss or damage. Close all pipe openings with caps or plugs. At final completion, thoroughly clean and deliver all work and equipment in an unblemished new condition. Keep all motors and bearings in watertight and dustproof covers during entire course of installation.

B. Protect floors, walls, framing and sheathing where pipe cutting and threading operations are conducted with plastic sheeting under plywood sheets. Extend plastic sheeting beyond the plywood. Clean-up metal cuttings, oil, etc., daily or as necessary to prevent debris from being tracked beyond the protected area. Damages, as determined by the Architect, due to the pipe cutting/threading operation shall be repaired by the responsible trade.

3.6 PIPE PENETRATION FIRE STOPPING

A. Install as recommended by manufacturer and in accordance with the product's UL listing. Below are the minimum installation requirements.

1. Install specified penetrating item(s) with required annular spacing in proper size wall or floor opening. Support penetrating item(s) adequately on both sides of construction.
2. Clean all opening and penetrating item surfaces in penetration area to remove loose debris, dirt, oil, wax, grease, old caulking, etc.
3. If needed or required for gypsum or concrete block walls, install specified galvanized steel wire mesh or sleeve recessed and centered inside wall around penetrating item(s) so that it is snug against perimeter of opening.
4. When required, install specified type and depth of backing material in annular space, recessed to required fill depth of fire stopping caulking.
5. Gun, trowel, and/or pump fire stopping sealant to specified depth in annular space around penetrating item(s). Trowel sealant surfaces flush with wall or floor surfaces to a smooth, defect-free finish. Where required, apply specified size caulking bead around penetrating item(s) at zero annular contact areas and tool smooth.

3.7 MECHANICAL PAINTING

A. Minimum Requirements: Comply with minimum requirements of Section 09900, Painting. All mechanical equipment, piping, insulation, etc., exposed in finished areas, storage rooms and other locations except mechanical equipment rooms will be painted under Section 09900.

B. Painting Materials: Material shall comply with Section 09900, Painting.

C. Iron Work: Paint hangers, rods, anchors, guides, threads of galvanized pipe, bases, supports, uncoated sheet metal and other iron work without factory finish, exposed to weather, located in moist concealed spaces and moist equipment rooms**,** one coat acid-resisting black paint. Apply one (1) coat Dixon's Aluminum Graphite No. 209 paint over the (1) coat primer as recommended by paint manufacturer to all hot metal surfaces.

D. Sheet Metal: Apply one coat of zinc chromate to mechanical sheet metal exposed to weather, except no painting required on aluminum or stainless steel. Apply one coat of flat black paint to the inside of unlined ducts behind all grilles and registers.

E. Insulated Piping and Other Insulated Surfaces: Paint insulated piping in half-round, split tile, or other inaccessible locations, one (1) coat asphalt emulsion.

3.8 TEMPORARY HEATING

A. Comply with requirements of Section 01500.

B. Permanent mechanical systems' equipment utilized for temporary heating, ventilating shall be started with all controls and safeties installed and operational. Start-up shall be done by a factory approved mechanic only.

C. Owner's warranties shall not be abridged by contractor's use of the permanent systems' equipment prior to final acceptance. Warranty period shall begin at final completion.

3.9 MECHANICAL WORK CLOSEOUT

A. General: Refer to the Division 1 sections for general closeout requirements. Calibrate all equipment requiring same.

B. Record Drawings: Submit record set of drawings required in Section 01720, Submittals, or as previously specified in this Section.

C. Closeout Equipment/Systems Operations: Sequence operations properly so that work of project will not be damaged or endangered. Coordinate with seasonal requirements. Operate each item of equipment and each system in a test run of appropriate duration with the Architect present, and with the Owner's operating personnel present, to demonstrate sustained, satisfactory performance. Adjust and correct operations as required for proper performance. Clean and lubricate each system, and replace dirty filters, excessively worn parts and similar expendable items of the work.

D. Operating Instructions: Conduct a full 8-hour walk-through instruction seminar for the Owner's personnel who are to be involved in the continued operation and maintenance of mechanical equipment and systems. Provide written instructions outlining and explaining the identification system, operational diagrams, emergency and alarm provisions, sequencing requirements, seasonal provisions, security, safety, efficiency and similar features of the systems. Provide video taping as outlined in Section 01770.

3.10 BALANCING

A. Balancing of the Heating, Ventilating and Air Conditioning systems shall be done in accordance with Section 15990 by a firm established in the State of Oregon providing this service and shall have the Architect's approval.

B. The Contractor shall have the system in complete operation, including controls, with all balancing dampers, valves, etc., open prior to notifying the Owner that the system is ready for balancing.

END OF SECTION

PART 1 - GENERAL

1.1 DESCRIPTION

A. Provide pipe, pipe fittings and related items required for complete piping system.

B. Related Work: Specified in Section 15090, Supports and Anchors, and in Section 15100, Valves.

1.2 QUALITY ASSURANCE

A. General: ASTM and ANSI Standards are indicated. In addition, special standards are referenced where neither ASTM nor ANSI Standards are applicable.

B. Concealed Plastic Piping: No concealed plastic piping inside the building unless approved by Code or Governing Authorities.

C. Definitions: Where piping fluid is not indicated in the following paragraphs, provide similar piping materials for similar fluids (i.e., "make-up water" = "domestic water"; "wet stand pipe" = "fire sprinkler pipe"; "drainage piping" = "sanitary/storm sewer piping").

1.3 STORAGE AND HANDLING

A. Deliver materials to the project site with galvanized pipe manufacturer's labels intact and legible as required by code.

B. Provide factory-applied end caps on each length of pipe and tube. Maintain end caps through shipping, storage and handling as required to prevent pipe-end damage and eliminate dirt and moisture from inside of pipe and tube. Protect flanges and fittings from moisture and dirt by inside storage and enclosure, or by packaging with durable, waterproof wrapping.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

A. Galvanized Steel Pipe:

1. Applications: Above ground only and 2" and smaller waste, vent and rain drain.
2. Pipe: Schedule 40, standard galvanized steel pipe, ASTM A-120.
3. Fittings: Cast iron threaded drainage pattern fittings, ANSI B16.12 for waste, vent and rain drain. Class 125 galvanized cast iron threaded fittings, ANSI B16.4 and B16.14 or Class 150 galvanized malleable iron threaded fittings, ANSI B16.3 for domestic water.

B. Black Steel Pipe:

1. Applications:
   a. Natural gas
   b. Heating water / Chilled water
   c. Fire sprinklers
2. Pipe: Systems 10" or smaller, operating below 400 psi, schedule 40, standard black steel pipe ASTM A-120 or A-53.

3. Underground Natural Gas and Compressed Air Piping: Coated with a minimum of ten mils of factory applied 100% thermosetting epoxy resin.
4. Threaded Fittings: For above ground installations only.
   a. Banded class 120 cast iron fittings, ANSI B16.4 to 125 psi.
   b. Banded class 150 malleable iron fittings, ANSI B16.3 to 150 psi.
   c. Banded class 300 malleable iron fittings, ANSI B16.3 to 300 psi.
5. Welding Fittings: For all underground installations, beveled ends, seamless fittings of the same type and class of piping above.
6. Flanged Fittings: For above ground installations only.
   a. Class 125 cast iron fittings, ANSI B16.2 including bolting to 125 psi.
   b. Class 150 steel welding neck flanges, ANSI B16.9 to 150 psi.
   c. Class 250 cast iron fittings, ANSI B16.1 including bolting to 250 psi.
   d. Class 300 steel welding neck flanges, ANSI B16.9 to 300 psi.
   e. Facing and Gasketing: Selected for service pressures and temperatures. Full-faced for cast iron and raised face for steel flanges.
7. Grooved Fittings: Permitted only for fire sprinklers and chilled water in accessible locations. None for heating water.

C. Cast Iron Soil Pipe:

1. Application: 1-1/2"" and larger.
   a. Sanitary waste
   b. Plumbing vent
   c. Rain drain
2. Pipe: Hubless cast iron soil pipe, CISPI 301-00/ASTM A 888.
3. Fittings: Hubless Cast Iron Fittings: CISPI 301-00.
4. Couplings:
   a. Light Duty: Standard couplings meeting CISPI 310.
   b. Medium Duty: No-hub couplings meeting CISPI 310 and incorporating ASTM C 564 gasket, type 304 SS corrugated shield and type 304 SS clamping bands. Two clamping bands on 1-1/2” thru 4” pipe and four bands on 6” thru 10” pipe.
   c. Heavy Duty: No hub couplings meeting CISPI 310 and FM 1680. ASTM C 564 neoprene gasket, type 304 SS corrugated shield and type 304 SS clamping bands. Four bands on 1-1/2” thru 4” pipe and 6 bands on 5” thru 10” pipe.
   d. Couplings to Dissimilar Pipe in Concealed Locations: Fernco "LowFlex" or approved substitute.
5. Manufacturers: Cast iron pipe and fittings – AB&I, Charlotte Pipe, Tyler Pipe. All pipe shall be labeled by the manufacturer.

D. Copper Pipe and Tube:

1. Application:
   a. Domestic water
   b. Heating, water
   c. Priming lines
   d. Sanitary waste and vent
   e. Chilled water
2. Pipe: ASTM B88.
   a. Above Ground Domestic Water, Heating Water, Compressed Air, Pressure Sewer, and Liquid Soap: Type L hard temper copper with soldered joints.
   b. Underground Domestic Water, Heating Water, Diesel Oil, Pressure Sewer, and Priming Lines: Type L soft annealed with no joints or type K hard tempered copper with silver soldered joints.

E. Plastic Pipe:

1. Application: Chilled water below grade where approved by Code.
2. Pipe: Polyvinyl chloride and chlorinated polyvinyl chloride plastic pipe for water service, SDR-PR pipe, ASTM D2241; Schedule 80, ASTM D1785.
3. Fittings: Provide fittings of the type indicated, matching piping manufacturer. Where not otherwise indicated, provide fittings produced and recommended for the service indicated.

F. Plastic Sewer Piping:

1. Application: 5' outside the building line and 4" through 18".
   a. Sanitary sewer
   b. Storm sewer
2. Pipe: Polyvinyl chloride (PVC), bell and spigot, rubber ring joint, ASTM 3034, SDR 35.
3. Fittings: Provide fittings matching piping manufacture for the service indicated by the manufacturer.

G. Plastic Pipe - Drainage:

1. Application: Three-story or less structures and where allowed by Code only.
   a. Sanitary waste (not to be used above grade)
   b. Plumbing vent
   c. Rain drain
2. Pipe:
   a. Acrylonitrile-butadiene-styrene (ABS) plastic drain, waste and vent piping and fittings (DWV): ASTM D2751 for 4" and 6"; ASTM D2680 for 8" and larger.
   b. Poly(vinyl chloride) (PVC) plastic drain, waste and vent pipe and fittings (DWV): ASTM D2665.
3. Fittings: Provide fittings of the type indicated, matching piping manufacture. Where not otherwise indicated, provide fittings produced and recommended for the service indicated by the piping manufacturer.

2.2 MISCELLANEOUS PIPING MATERIALS/PRODUCTS

A. Insulating (Dielectric) Fittings: Provide standard products recommended by the manufacturer for use in the service indicated, and which effectively isolate ferrous from non-ferrous piping (electrical conductance), prevent galvanic action, and reduce corrosion. Victaulic "Clear Flow."

B. Welding Materials: Provide welding materials as determined by the installer to comply with installation requirements.

C. Soldering and Brazing Materials: Provide soldering materials as determined by the installer to comply with installation requirements.

1. Tin-Antimony Solder: ASTM B32, Grade 95TA.
2. Lead-Free Solder: ASTM B32, Grade HB. Harris "Bridgit" approved.
3. Silver Solder: ASTM B32, Grade 96.5TS.

D. Gaskets for Flanged Joints: ANSI B16.21; full-faced for cast-iron flanges; raised-face for steel flanges. Pressure and temperature rating required for the service indicated.

E. Sleeve Seal: Rubber-link pipe wall and casing closure. Thunderline Link-Seal. For fire rated wall, floor or ceiling penetrations, 3-M "CP-25" caulk, "No. 303" putty and/or "PSS 7904" sealing system.

F. Strainers: "Y-pattern," iron bronze body rated for pressures indicated with blow-off connection and 20 mesh stainless steel screen.

G. Tracer Wire: 14 gauge, single strand, copper wire with blue insulation for water, green for sanitary and storm sewers, and yellow for gas. 3M "DBY" direct bury splice kit required at all splices.

2.3 BACKFILL MATERIALS

A. Subbase Materials: A graded mixture of gravel, sand, crushed stone or crushed slag.

B. Finely-Graded Subbase Material: Well graded sand, gravel, crushed stone or crushed slag, with 100% passing a 3/8" sieve.

C. Backfill Material: Soil material suitable for compacting to the required densities, and complying with AASHTO designation M145, Group A-1, A-2-4, A-2-5. or A-3.

D. Stabilization Fabric: Nonwoven stabilization and drainage fabric. Mirafi 140S or 140M.

PART 3 - EXECUTION

3.1 PIPE INSTALLATION

A. General: Install pipe, tube and fittings in accordance with recognized industry practices. Install each run accurately aligned with a minimum of joints and couplings, but with adequate and accessible unions and flanges for disassembly, maintenance and/or replacement of valves and equipment. Reduce sizes (where indicated) by use of reducing fittings.

B. Piping Runs: Route piping close to and parallel with walls, overhead construction, columns and other structural and permanent-enclosure elements of the building (pitched for drainage). If not otherwise indicated, run piping in the shortest route which does not obstruct usable space or block access for servicing the building or equipment and avoid diagonal runs. Wherever possible in finished and occupied spaces, conceal piping from view. Do not encase horizontal runs in solid partitions.

C. Piping: Install for services as specified in Part 2. The following are special requirements and Contractor's options.

1. Underground Drainage Pipe: Install cast iron soil pipe for the following conditions. When specified in Part 2 of this Section and where allowed by Code, plastic piping may be installed in lieu of cast iron piping.
   a. Under the building to 5' outside the building structure.
   b. 5' each way from a potable water line crossing.
   c. First section (minimum 5') from any connection to underground structures such as catch basins, manholes, disposal well or tank, etc.
   d. Through all fill areas where pipe cannot be rested on undisturbed earth.
   e. At contractor's option in lieu of concrete or clay sewer pipe (cast iron piping with Ty-seal rubber ring joints).
2. Storm Drainage Pipe, 12" Diameter and Larger: Corrugated galvanized steel pipe and fittings.
3. Contractor's Options:
   a. Standard length of PVC, conforming to AWWA C900, Class 200 with rubber ring joints may be used in place of concrete sewer pipe providing pipe is supported by

undisturbed earth and is installed in strict accordance with the manufacturer's recommendations.

b. When approved by the Governing Authority, Schedule 40 ABS-DWV or PVC-DWV socket solvent joint piping may be utilized within the project property boundaries.

4. Heating and Chilled Water Piping: Standard black schedule 40 steel pipe and 125 pound black cast screwed or approved welding fittings for pressures up to 75 psi. Welded connections on all piping underground, piping in tunnel or tile or otherwise inaccessible and on all equipment room headers 4" and over. Weldolets, Threadolets, or schedule 80 shaped nipples may be used for take-offs up to half the nominal size of main.

5. Underground Gas and Compressed Air Piping: Standard schedule 40 black steel pipe with welding fittings coated with a minimum of ten mils of 100% thermosetting epoxy resin, Scotchkote No. 203 factory applied per resin manufacturer's recommendations. Wrap all joints with 10 mil polyvinyl chloride pipewrap tape to a total thickness of 40 mils. Provide one 15 pound magnesium anode per each 100' of underground pipe, attached to coupling or other fitting with No. 10 copper wire. No underfloor slab natural gas piping except as provided for by code.

D. Tracer Wire: Install tracer wire as close to underground non-metallic water, sanitary and storm sewers and gas pipe in the trench as possible. Tracer wire shall be accessible at grade via all services, valve and meter boxes, curb cocks, cleanouts at the building, manholes (inside the cover near the top), etc. Locate all points on the record as-installed drawings. Splice into utility tracer system where available. Comply with code requirements.

3.2 PIPING JOINTS

A. General: Provide joints of the type indicated in each piping system, and where piping and joint as manufactured form a system, utilize only that manufacturer's material.

B. Cast Iron "No-Hub": All joints in accordance with the Cast Iron Soil Pipe Institute (CISPI) Designation No. 310-90 "Installation Procedures for Hubless Cast Iron Soil Pipe and Fittings For Sanitary and Storm Drain, Waste and Vent Piping Applications." Horizontal runs of 5" and greater shall be braced as indicated in Figure 4 for "rodding" restraints. Application of couplings as follows:

1. Light duty couplings: All vent piping and all drainage and waste piping above grade.
2. Medium duty couplings: All aboveground waste and drainage piping unless indicated otherwise.
3. Heavy duty couplings:
   a. All underground installations.
   b. All rain drain leader joints located more than 20 feet below the roof drain.

D. Ferrous Threaded Piping: Thread pipe in accordance with ANSI 82.l; cut threads full and clean using sharp dies. Ream threaded ends to remove burrs and restore full inside diameter. Apply pipe joint compound or pipe joint tape (Teflon) where recommended by pipe/fitting manufacturer, on male threads at each joint and tighten joint to leave no more than 3 threads exposed.

E. Solder Copper Tube and Fitting Joints: In accordance with recognized industry practice. Cut tube ends squarely, ream to full inside diameter, and clean outside of tube ends and inside of fittings. Apply solder flux to joint areas of both tubes and fittings. Insert tube full depth into fitting, and solder in a manner which will draw solder full depth and circumference of joint. Wipe excess solder from joint before it hardens. "T-Drill" field formed tees may be utilized where the main is at least two pipe sizes larger than the branch.

F. Braze Copper Tube and Fitting Joints: Where indicated, in accordance with ANSI/ASME B31.5. Pass a slow stream of dry nitrogen gas through the tubing at all times while brazing to eliminate formation of copper oxide.

G. Weld Pipe Joints: In accordance with recognized industry practice and as follows:

1. Weld pipe joints only when ambient temperature is above 0 degrees F.
2. Bevel pipe ends at a 37.5 degree angle, smooth rough cuts, and clean to remove slag, metal particles and dirt.
3. Use pipe clamps or tack-weld joints with 1" long welds; 4 welds for pipe sizes to 10"; 8 welds for pipe sizes up to 20".
4. Build up welds with a stringer-bead pass, followed by a hot pass, followed by a cover of filler pass. Eliminate valleys at center and edges of each weld. Weld by procedures which will ensure elimination of unsound or unfused metal, cracks, oxidation, blow-holes and non-metallic inclusion.
5. Do not weld out piping system imperfections by tack-welding procedures; refabricate to comply with requirements.
6. Install forged branch-connection fittings wherever branch pipe is indicated, or install regular "T" fitting at Contractor's option.

H. Flanged Joints: Match flanges within piping system, and at connections with valves and equipment. Clean flange faces and install gaskets. Tighten bolts to provide uniform compression of gasket.

I. Plastic Pipe/Tube Joints: Comply with manufacturer's instructions and recommendations, and with applicable industry standards:

1. Heat Joining of Thermoplastic Pipe: ASTM D-2657.
2. Making Solvent-Cemented Joints: ASTM D-2865 and ASTM F-402.

J. Insulating (Dielectric) Fittings: Comply with manufacturer's instructions for installing unions or fittings. Install in a manner which will prevent galvanic action and stop corrosion where the "joining of ferrous and non-ferrous piping" is indicated.

K. Changes in Direction: Use fittings for all changes in direction. Run lines parallel with building surfaces.

L. Line Grades:

1. Drainage Lines: Run at maximum possible grade and in no case less than 1/4" per foot within building.
2. Vents: Pitch for drainage 1/4" per 10'.
3. Water: Pitch to low points and install hose bib drains. 3' minimum depth of ground cover for all lines outside building unless otherwise noted.
4. Heating/Chilled Water Piping: Pitch 1" to 40' minimum to low point drips or drains.

M. Unions and Flanges: At all equipment to permit dismantling and elsewhere as consistent with good installation practice.

N. Expansion: Provide loops, swing joints, anchors, runouts and spring pieces to prevent damage to piping or equipment.

3.3 MISCELLANEOUS PIPING EQUIPMENT

A. Floor, Wall and Ceiling Plates: Chrome plated pressed steel or brass screw locked split plates on all pipe penetrations in finished spaces.

B. Strainers: Install in a manner to permit access for cleaning and screen removal and with blow-off valve.

C. Sleeves: At all penetrations of concrete or masonry construction. PVC, 24 gauge galvanized steel or Schedule 40 galvanized steel pipe. Use steel pipe sleeves through beams, footings, girders or columns and for all penetrations of walls or floors below grade. Where floor finish is ceramic tile, terrazzo, or similar material extend standard steel pipe sleeves 1-1/2" above finished floor. Fabricate sleeves 1" diameter larger than pipe or insulation. PVC and sheet metal sleeves at non-structural penetrations only.

D. Sleeve Caulking: Caulk insulated pipe with rubber link seal. Grout uninsulated pipe with cement mortar or approved waterproof mastic. All caulking or grouting shall extend full depth of sleeve. Utilize rubber sealing links in lieu of caulking. Install UL sealing caulk, putty and/or system at all penetrations of fire rated walls, floors and ceiling**.**

3.4 EXCAVATING

A. General: Do not excavate for mechanical work until the work is ready to proceed without delay, to minimize the total time lapse from excavation to completion of backfilling. Comply with all applicable Federal and state safety regulations.

B. Width: Excavate for piping with 6" to 9" clearance on both sides of pipe, except where otherwise shown or required for proper installation of pipe joints, fittings, valves and other work. Excavate for other mechanical work to provide minimum practical but adequate working clearances.

C. Depth for Direct Support: For work to be supported directly on undisturbed soil, do not excavate beyond indicated depths, and hand-excavate the bottom cut to accurate elevations. Support the following work on undisturbed soil at the bottom of the excavations:

1. Piping of 5" and less pipe/tube size.
2. Cast-in-place concrete.

D. Depth for Subbase Support: For large piping (6" pipe size and larger), tanks and where indicated for other mechanical work, excavate for installation of subbase material in the depth indicated, or, if not otherwise indicated, 6" below bottom of work to be supported.

E. Depth for Exterior Piping: Excavate for exterior water-bearing piping (water, steam condensate, drainage) so that the top of piping will not be less than 3' vertical distance below finished grade.

F. Depth for Unsatisfactory Soil Conditions: Where unsatisfactory soil condition at the bottom of excavation exists, excavate additional depth as directed to reach satisfactory soil-bearing condition. Backfill with subbase material, compacted as directed, to indicated excavation depth.

3.5 BASE PREPARATION

A. Subbase Installation: Where indicated, install subbase material to receive mechanical work, and compact by tamping to form a firm base for the work. For 4" and larger piping, horizontal cylindrical tanks and similar work, shape and subbase to fit the shape of the bottom 90 degrees of the cylinder, for uniform continuous support. Provide finely-graded subbase material for wrapped, coated and plastic pipe and tank. Shape subbases and bottoms of excavation with recesses to receive pipe bells, flanged connections, valves and similar enlargements in the piping systems and set bottom of trench at proper pitch and correct elevations with subbase material.

B. Concrete Encasement: Where piping under roadways is less than 2'-6" below surface of roadway, provide 4" base slab of concrete to support piping. After piping is installed and tested,

provide 4" thick encasement (sides and top) of concrete before backfilling. Provide Class 250 concrete for encasement and slab.

3.6 BACKFILLING

A. Do not backfill until installed mechanical work has been tested and accepted wherever testing is indicated. Install drainage fill where indicated, and tamp to a uniform firm density. Backfill with finely-graded subbase material to 6" above wrapped, coated and plastic piping and tanks, and to center line of other tanks (where recommended by tank manufacturer, use "pea gravel" backfill). Condition backfill material by either drying or adding water uniformly, to whatever extent may be necessary to facilitate compaction to the required densities. Do not backfill with frozen materials.

3.7 CLEANING

A. General: Clean all dirt and construction dust and debris from all mechanical piping systems and leave in a new condition. Touch up paint where necessary.

B. Domestic Water System: Flush with clean water to eliminate grease, cuttings and foreign matter; run water until clear and free of oil. Chlorinate domestic water as per procedure outlined by Board of Health.

C. Sanitary and Storm Drainage System:

1. Remove construction debris from cleanouts, drains, strainers, baskets, traps, etc., and leave same accessible and operable. Place plugs in the end of uncompleted conduit at the end of the day or whenever work stops.
2. Before final acceptance of completed sewer system, flush and clean the entire system with water. Trap and remove solid material obtained from flushing and cleaning from the new system. Do not allow debris to enter the existing sewer system.

D. Gas: Blow clear of debris with nitrogen or oil free air. Clean all low point strainers and pockets.

E. Heating Water Systems:

1. Use one pound of trisodium phosphate per 50 gallons in the system, or one pound of sodium carbonate for each 30 gallons in the system or one pound of sodium hydroxide (lye) for each 50 gallons in the system.
2. Fill, vent and circulate the system with this solution at design operating temperature. After circulating for four hours, drain and fill with fresh water.
3. Test for pH and add sufficient amount of the cleaning chemical to obtain a pH between 7 and 8.
4. Clean all strainers and remove start-up strainers (from suction diffusers) after the system has operated for one week.

E. Chiller Water: Flush with clean water.

3.8 TEST

A. General:

1. Minimum duration of two hours or longer, as directed for all tests. Furnish report of test observation signed by qualified inspector. Make all tests before applying insulation, backfilling, or otherwise concealing piping or connecting fixtures or equipment. Where part of the system must be tested to avoid concealment before the entire system is complete, test that portion separately, same as for entire system.

2. Provide all necessary temporary equipment for testing, including pump and gauges. Remove control devices before testing and do not use piping system valves to isolate sections where test pressure exceeds valve pressure rating. Fill each section with water and pressurize for the indicated pressure and time.
3. Observe each test section for leakage at end of test period. Test fails if leakage is observed or if pressure drop exceeds 5% of test pressure.

B. Repair:

1. Repair piping system sections which fail the required piping test by disassembly and re-installation, using new materials to the extent required to overcome leakage. Do not use chemical stop-leak compounds, solder, mastics, or other temporary repair methods.
2. Drain test water from piping systems after testing and repair work has been completed.

C. Sewer: Furnish all facilities and personnel for conducting the test. Test in accord with the requirements of the State Plumbing Inspector and local authorities.

D. Plumbing Waste and Vent Piping: Hydrostatic test by filling to highest point, but not less than 10' water column on major horizontal portion.

E. Water Piping: Hydrostatic pressure of 100 psig without loss for four hours.

F. Natural Gas Piping: One half hour minimum air at 60 psig for 2 psig gas, and 15 minutes at 10 psig for 7" water gauge natural gas or as approved and certified by serving utility.

G. Heating and Chilled Water Piping: 75 psig hydrostatic for 30 psig systems without loss for four hours.

H. Tanks and Equipment: Hydrostatic pressure to 1.5 times operating pressure.

END OF SECTION

PART 1 - GENERAL

1.1 DESCRIPTION

A. The requirements of this section apply to the mechanical piping and equipment systems specified elsewhere in these specifications.

B. Provide pipe and equipment hangers, supports, anchors and related items for complete anchor, hanger and support systems.

1.2 QUALITY ASSURANCE

A. Standards: The Manufacturers Standardization Society (MSS) of the Valve and Fittings Industry Practice SP-58 and SP-69 are referenced in this section.

B. Provide factory-fabricated horizontal piping hangers, clamps, hanger rod, shields, supports, etc., of the indicated MSS type and size.

C. Seismic Requirements: Provide seismic restraints in accordance with UBC Section 1632. Design restraint systems in accordance with "Seismic Restraint Manual: Guidelines for Mechanical Systems," Second Edition, 1998, SMACNA, or “A Practical Guide to Seismic Restraint” ASHRAE RP-812, 1999.

1.3 SUBMITTALS

A. Submittals: In accordance with Section 01330.

B. Catalog Data: Submit construction details, and performance characteristics for each type and size of anchor, hanger, and support.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Manufacturers: B-Line, Carpenter & Paterson, Grinnell, Michigan, Superstrut, Tolco, or accepted substitute.

B. Listed Types: MSS Piping Types listed with Grinnell figure numbers in parentheses where applicable (or other manufacturers as noted).

2.2 SUPPORTS

A. Horizontal Piping Hangers and Supports:

1. Adjustable Clevis Hanger: MSS Type 1 (Fig. 260).
2. Adjustable Band Hanger: MSS Type 7 (Fig. 97), fabricated from steel.
3. Adjustable Swivel-Band Hanger: MSS Type 10 (Fig. 70).
4. Clamp: MSS Type 4 (Fig. 212, 216).
5. Double-Bolt Clamp: MSS Type 3 (Fig. 295A, 295H), including pipe spacers.

B. Equipment and Piping Supports:

1. Channel Support System: Galvanized, 12 gauge channel and bracket support systems, single or double channel as indicated on the Drawings or as required by piping and equipment weights. Grinnell "Power Strut" channel. Acceptable manufacturers: Super Strut, Globestrut, Bee, Kindorf or Unistrut.
2. Steel Brackets: Welded structural steel shapes complying with one of the following:
   a. Light Duty: MSS Type 31 (Fig. 194).
   b. Medium Duty: MSS Type 32 (Fig. 195).
   c. Heavy Duty: MSS Type 33 (Fig. 199).
3. Rooftop Pipe Stands: MIRO Industries model 24-R or accepted substitute.

C. Vertical Pipe Clamps:

1. Two-Bolt Riser Clamp: MSS Type 8 (Fig. 261).
2. Four-Bolt Riser Clamp: MSS Type 42 include pipe spacers at inner bolt-holes.

D. Hanger Rod Attachment:

1. Hanger Rod: Grinnell Fig. 140 or 146 for all sizes. Right hand threaded.
2. Turnbuckles: MSS Type 13 (Fig. 230).
3. Weldless Eye-Nut: MSS Type 17 (Fig. 290).
4. Malleable Eye-Socket: MSS Type 16 (Fig. 110R).
5. Clevises: MSS Type 14 (Fig. 299).

E. Building Attachments:

1. Concrete Inserts: MSS Type 18 (Fig. 282), steel or Grinnell Power-Strut PS349 continuous channel. Acceptable Manufacturers: Michigan Hanger, Globestrut, Unistrut, Super Strut.
2. Clamps: MSS Type 19 (Fig. 285, 281), Type 20, 21 (Fig. 225, 226, 131), Type 23 (Fig. 86, 87, 88), Type 25 (Fig. 227), Type 27 through 30 where applicable.

F. Saddles and Shields:

1. Protection Saddles: MSS Type 39 (Fig. 160).
2. Protection Shields: MSS Type 40 (Fig. 167).
3. Preinsulated Pipe Supports: Pipe Shields Inc. or accepted substitute.
   a. Pipe supported on rods - Models A1000, A2000, A3000, A4000 and A9000.
   b. Pipe supported on flat surfaces - Models A1000, A2000, A5000, A6000 and A7000.
   c. Pipe supported on pipe rolls - Models A3000, A4000, A5000, A6000 and A8000.

G. Miscellaneous Hanger Materials:

1. Metal Framing: Provide products complying with NEMA STD ML 1.
2. Steel Plates, Shapes and Bars: ASTM A-36.
3. Cement Grout: Portland cement (ASTM C-150, Type I or Type III) and clean uniformly graded, natural sand (ASTM C-404, Size No. 2). Mix at a ratio of 1.0 part cement to 3.0 parts sand, by volume with only the minimum amount of water required for placement and hydration.
4. Heavy Duty Steel Trapezes: Fabricate from steel shapes selected for the loads required; weld steel in accordance with AWS Standards.
5. Pipe Guides: Provide factory-fabricated guides, of cast semi-steel or heavy fabricated steel, consisting of a bolted two-section outer cylinder and base with a two-section guiding spider bolted tight to the pipe. Size guide and spiders to clear pipe and insulation (if any), and cylinder. Provide guides of the length recommended by the manufacturer to allow indicated travel.
6. Standard Bolts and Nuts: ASTM A 307, Grade A.

7. Concrete Anchors: Rawl Lok/Bolt, Hilti "HSL," ITT Phillips, Red Head Wedge Anchors, Ramset Trubolt or Dynabolt or accepted substitute.
8. Shop Primer: Manufacturer's standard rust inhibitive primer.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General: Proceed with the installation of hangers, supports and anchors only after the required building structural work has been completed in areas where the work is to be installed. Correct inadequacies including (but not limited to) the proper placement of inserts, anchors and other building structural attachments.

1. Install hangers, supports, clamps, and attachments to support piping and equipment properly from the building structure. Use no wire or perforated metal to support piping, and no supports from other piping or equipment. For exposed continuous pipe runs, install hangers and supports of the same type and style as installed for adjacent similar piping.
2. Prevent electrolysis in the support of copper tubing by the use of hangers and supports which are copper plated or by other recognized industry methods.
3. Support fire sprinkler piping independently of other piping and in accordance with NFPA Pamphlet 13.
4. Arrange supports to prevent eccentric loading of joists and joist girders. Locate supports at panel points only.

B. Provisions for Movement:

1. Install hangers and supports to allow controlled movement of piping systems and to permit freedom of movement between pipe anchors, and to facilitate the action of expansion joints, expansion loops, expansion bends and similar units.
2. Install hangers and supports so that equipment and piping live and dead loading and stresses from movement will not be transmitted to connected equipment.
3. Install hangers and supports to provide the indicated pipe slopes, and so that maximum pipe deflections allowed by ANSI B31 are not exceeded. Comply with the following installation requirements:

    a. Clamps: Attach clamps, including spacers (if any), to piping outside the insulated piping support. Do not exceed pipe stresses allowed by ANSI B31.
    b. Insulated Pipe Supports: Insulated pipe supports shall be supplied and installed on all insulated pipe and tubing.
    c. Load Rating: All insulated pipe supports shall be load rated by the manufacturer based upon testing and analysis in conformance with ASME B31.1, MSS SP-58, MSS SP-69 and MSS SP-89.
    d. Support Type: Manufacturer's recommendations, hanger style and load shall determine support type.
    e. Insulated Piping Supports: Where insulated piping with continuous vapor barrier or where exposed to view in finished areas is specified, install hard maple wood insulation shields (Elcen Fig. 216) or steel pipe covering protection shields (MSS type 39) at each hanger.

C. Pipe Support:

1. Vertical Spacing: Support at base, at equivalent of every floor height (maximum 10' as required by Code) and just below roof line.

2. Screwed or Welded Steel or Copper Piping: Maximum hanger spacing shall be as follows:

	Steel	Copper
1-1/4" and smaller	7' span	6' span
1-1/2" pipe	9' span	6' span
2" pipe	10' span	10' span
2-1/2" & larger	12' span	10' span

3. Cast Iron Soil Pipe:
   a. Bell and Spigot: One hanger for each pipe section, close to hub, maximum hanger spacing of 5', except pipe exceeding 5' in length may be supported at not more than 10' intervals and within 18" of any joint.
   b. Hubless and Compression Joint: At every other joint except when developed length exceeds 4', then at each joint.
   c. Additional Support: Provide at each horizontal branch and/or at concentrated loads to maintain alignment and prevent sagging.
4. Polyvinyl Chloride, Polypropylene and Other Plastic Pipe: Maximum hanger spacing and minimum rod diameters as follows:
   a. Continuous support 1/2" to 4" pipe size Fee & Mason No. 109 channels with Fee & Mason No. 108 hanger. Lay pipe directly into the channel with fittings or couplings placed in spaces between channel sections. Secure piping to the channel at intervals between hangers with a few turns of vinyl electrical tape.
   b. Non-Continuous Support: Maximum 4' spans or shorter if required by manufacturer for temperatures and pipe schedule.
   c. Arrange supports to allow free movement, but restrict upward movement of lateral runs so as not to create reverse grade on drainage pipe. Use double bolt clamp or band hanger with restraint (Tolco fig. 25).
5. Install additional hangers or supports at concentrated loads such as pumps, valves, etc. to maintain alignment and prevent sagging.
6. Support Rod: Hanger support rods sized as follows:

Pipe and Tube Size		Rod Size	
Inches	mm	Inches	mm
1/2” to 4”	12.7 to 101.6	3/8”	9.5
5” to 8”	127.0 to 203.2	1/2”	12.7
10” to 12”	254.0 to 304.8	5/8”	15.9

D. Adjust hangers and supports to bring piping to proper levels and elevations.

E. Provide all necessary structural attachments such as anchors, beam clamps, hanger flanges and brackets in accordance with MSS SP-69. Attachments to beams wherever possible. Supports suspended from other piping, equipment, metal decking, etc., are not acceptable.

F. Horizontal banks of piping may be supported on common steel channel member spaced not more than the shortest allowable span required on the individual pipe. Maintain piping at its relative lateral position using clamps or clips. Allow lines subject to thermal expansion to roll axially or slide. Size channel struts for piping weights.

G. Installation of drilled-in concrete anchors shall comply with the manufacturers instructions for working load, depth of embedment, and spacing between anchors and from the edge of the slab. Where mounting holes are oversize for the anchor, install neoprene washer-bushings to provide a snug fit.

3.2 INSTALLATION OF PIPE ANCHORS

A. Install anchors at the proper locations to prevent stresses from exceeding those permitted by ANSI B31, where recommended in SMACNA "Seismic Restraint Manual" or exceeding

manufacturer's recommended loading, and to prevent the transfer of loading and stresses to connected equipment.

B. Fabricate and install anchor by welding steel shapes, plates and bars to the piping and/or equipment and to the structure. Comply with ANSI B31 and AWS standards and SMACNA "Seismic Restraint Manual."

C. Bolting: Provide standard plate washers under heads and nuts of bolts bearing on wood. Soap threads of lag bolts prior to installing.

D. Structural Blocking: Locate as indicated and as required to support mechanical piping and equipment.

E. Where expansion compensators are indicated, install anchors in accordance with the expansion unit manufacturer's written instructions, to limit movement of piping and forces to the maximums recommended by the manufacturer of each unit.

F. Anchor Spacings: Install anchors at the ends of principal pipe runs, at intermediate points in pipe runs between expansion loops and bends. Make provisions for presetting of anchors as required to accommodate both expansion and contraction of piping.

G. Painting: Refer to Section 09900.

3.3 EQUIPMENT RESTRAINTS

A. Systems and equipment shall be anchored to resist displacement, including sliding, swinging, and overturning due to seismic forces. Friction due to equipment weight shall not be considered as anchorage.

B. The contractor shall retain a consulting engineer or equipment manufacturer to design the seismic restraint systems.

C. Contractor shall submit calculations and shop drawings, sealed and signed by a professional engineer, showing seismic restraint design for all equipment, piping and ductwork required to be braced. Design shall show analysis of supporting structure, anchorages, and restraints in accordance with UBC Section 1632.

D. Seismic restraint system components shall be approved by the California Office of Statewide Health Planning and Development (OSHPD) for fixed equipment anchorages. Acceptable manufacturers: Mason Industries, Tolco, or approved.

END OF SECTION

PART 1 - GENERAL

1.1 DESCRIPTION

A. The requirements of this section apply to the valving for the piping system specified elsewhere in these specifications.

B. Provide valves where shown on the Drawings and specified herein.

1.2 QUALITY ASSURANCE

A. Provide factory fabricated valves of the type, body material and pressure class indicated and service indicated.

B. Valve Sizes: Same as connecting pipe size.

C. Bronze valves shall comply with MSS-SP-80. Iron gate and globe valves shall comply with MSS-SP-70.

PART 2 - PRODUCTS

2.1 VALVE TYPES

A. General: Where possible, provide valves from a single manufacturer.

B. Acceptable Manufacturers: Milwaukee, Crane, Grinnell, Nibco, Hammond, Stockham, Watts, and Walworth. Grooved end valves Victaulic, Gruvlock, or accepted substitute. Grinnell numbers are given except as noted.

C. Domestic Water Systems:

1. Valves 2” and Smaller:
   a. Ball: Two-piece, bronze body, standard port, 400 psi WOG, Fig. 3500.
   b. Check: Bronze body, swing check, 200 psi WOG, Fig. 3300.
   c. Globe (shutoff): Bronze body, Teflon disc, 200 psi WOG, Fig. 3210.
   d. Globe (throttling): Bronze body, full plug disc, 600 psi WOG, Fig. 3270.
2. Valves 2” through 12”:
   a. Ball: Three-piece, bronze body, standard port, 600 psi WOG, Fig. 3800.
   b. Butterfly: Bronze or epoxy coated cast iron body, aluminum bronze disc, 200 psi WOG, series 8000.
   c. Gate (to 3”): Bronze body, non-rising stem, 200 psi WOG, Fig. 3050.
   d. Gate (4” to 12”): Iron body, bronze trim, non-rising stem, solid wedge, bolted bonnet, 200 psi WOG, Fig. 6060A.

D. Heating / Chilled Water:

1. Valves up to 12":
   a. Ball: Two-piece, bronze body, standard port, 400 psi WOG, Fig. 3500.
   b. Gate (to 3”): Bronze body, non-rising stem, 200 psi WOG, Fig. 3050.
   c. Gate (4” to 12”): Iron body, non-rising stem, solid wedge, bolted bonnet, 200 psi WOG, Fig. 6060A.

d. Globe (shutoff): Bronze body, Teflon disc, 200 psi WOG, Fig. 3210.
e. Globe (throttling): Bronze body, full plug disc, 600 psi WOG, Fig. 3270.
f. Butterfly: Iron body, aluminum bronze disc, 200 psi WOG, series 8000.
g. Check: Bronze or iron body swing check, 200 psi WOG, Figs. 3300 and 6300.

E. Natural Gas: UL listed or AGA approved valves.

1. 10 psig or Less:
   a. Full Port Ball: Watts FBV-3.
   b. Lubricated Plug: Walworth 1700F.

F. Non-Slam Check Valves:

1. 125 psi or less, 2-1/2" - 10", Fig. 402-460
2. 250 psi or less, 2-1/2" - 30", Fig. 502½-580

G. Butterfly Valve Operators: Locking lever for shut-off service; “Memory Stop” for lever handle and slotted index plate for infinite number of settings for throttling service; gear operator with babbitt sprocket rim for chain-operated valves and gear operators on all 6” or larger valves.

H. Butterfly Valve Style: Lug-type with cap screws for all valves utilized for equipment isolation for servicing.

I. Plug Valve Operators: Provide operating handle for each plug valve.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General: Comply with the following requirements:

1. Install valves where required for proper operation of piping and equipment, including valves in branch lines where necessary to isolate sections of piping.
2. Locate valves in accessible spaces (or behind access panels) and so that separate support can be provided when necessary.
3. Install valves with stems pointed up, in the vertical position where possible, but in no case with stems pointed downward from a horizontal plane.

B. Insulated Valves: Install extended-stem valves in all piping specified as insulated, and arrange in the proper manner to receive insulation.

C. Mechanical Actuators: Install mechanical actuators with chain operators where indicated, where valves 4" and larger are mounted more than 7' above the floor, and where manual operation is difficult because of valve size, pressure differential or other operating conditions. Drop chains to 6'-6" above the floor.

D. Selection of Valve Ends (Pipe Connections): Select and install valves with ends matching the types of pipe/tube connections.

E. Valve Access: Provide access panels to all valves installed behind walls, in furring or otherwise inaccessible.

F. Lubricant-Seal: Select and install plug valves with lubricant-seal except where frequent usage is indicated or can be reasonably expected to occur.

G. Fluid Control: Install gate, ball, globe, plug, and butterfly valves to comply with ANSI B31. Install check valves where indicated and where flow reversal is obviously not desirable and can be reasonably expected to occur, including piping at the discharge of pumps. Install silent check valves where necessary to eliminate water hammer occurring from reversal of flow.

H. Application: Valve type and style as shown on the Drawings. Where style is not indicated, use the following:

1. Domestic Water: Ball valves for 2" and smaller and butterfly for 2" and over.
2. Heating / Chilled Water: Use rising stem gate valves in mechanical and/or boiler rooms and globe valves for throttling service. For temperatures up to 200 deg. F, ball and butterfly valves may be used with lever operators with infinite number of settings up to 4" sizes and gear operator with setting indicator on larger sizes.

END OF SECTION

PART 1 - GENERAL

1.1 DESCRIPTION

A. The requirements of this section apply to the vibration isolation for mechanical equipment specified elsewhere.

1.2 QUALITY ASSURANCE

A. Isolator Engineering: Selected and furnished by the equipment manufacturer. Select isolators for 98% efficiency unless indicated otherwise on the Drawings.

B. Manufacturer: Provide field installed isolation required from a single manufacturer where possible.

1.3 SUBMITTALS

A. Provide product data sheets on all vibration isolators and seismic restraints.

B. Provide itemized list showing the items of equipment or piping to be isolated, isolator type and model number selected, isolator loading and deflection, and reference to specified drawings showing frame and construction.

C. Provide manufacturer's drawings showing equipment frame construction for each item including dimensions, structural member sizes and support locations.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Manufacturers: Amber/Booth, Mason Industries, Vibrex.

B. Manufacturer Model Numbers: Amber/Booth figure numbers are listed unless indicated otherwise.

2.2 VIBRATION ISOLATORS

A. Types of Isolators:

1. Open Spring: Series S.
2. Housed Spring: Type CT.
3. Hanger with Spring and Rubber Stop: Type BSR.
4. Rubber-in-Shear: Types RV and RVD.
5. Seismic Restraints: Mason Z-1011.

B. Spring Selection: Free standing, stable type with a one-to-one ratio on springs with deflections in excess of one inch. Provide with rails where indicated.

C. Noise and Vibration Barrier Hanger: For ductwork and piping where indicated. Target Enterprises Inc. "ARH-1" or accepted substitute.

D. Seismic and Start-Up Restraints: Select all isolators to withstand seismic loads equivalent two times the isolator load rating applied from any direction. Mason Industries type Z-1011 on all isolated equipment not utilizing isolators with integral restraints.

E. Flexible Pipe Connectors - Type SS: All stainless steel hose and braid with carbon steel connections. Male thread ends on flexible connectors 2" and smaller, and flanged connections on 1-1/2" and larger connectors.

2.3 EQUIPMENT FRAMES

A. Rigid Steel:

1. Mounting Frames and/or Brackets: Designed to carry the load of the equipment without causing mechanical distortion or stress to the equipment.
2. Welded Mounting Frames: I-beam or channel structural steel, with welded brackets to accept the isolators. Type SW.

B. Concrete Inertia Base:

1. Bases: Welded steel structural forms including steel reinforcing bars, welded in place running in both directions near the bottom of the base, and drilled steel members, with sleeves below the holes to receive anchor bolts. Employ height-saving brackets at all mounting locations. Size for 1.5 times the weight of the supported equipment. Type CPF.
2. Concrete: In accordance with Section 03300 .

PART 3 - EXECUTION

3.1 INSTALLATION

A. General: Install vibration isolators and flexible connectors as specified herein, as shown on the Drawings and as recommended by manufacturer.

B. Air Compressor, Pumps and HVAC Equipment: Mount compressors, fans and air handling units on structural steel base forming a common support for the fan (equipment) and motor.

C. Duct Connections: Install flexible duct connections on all externally spring isolated air handling units including roof mounted units down through roof curbs (and/or to unit side duct connections).

D. Flexible Pipe Connections:

1. Provide flexible connections on all piping to spring isolated equipment, where indicated on Drawings and for all coils mounted in spring isolated air handling units or plenums. Coils in rigid units and plenums do not require flexible connectors. Provide a flexible connection in both the supply and return connections to the coil as near the coil as possible.
2. Install connectors in a straight line as recommended by the manufacturer without offsets or twists and support pipe without any load on flexible connectors. Minimum live length shall be as follows:

Pipe Size	Minimum Live Length
1" through 1-1/2"	8"
2" through 2-1/2"	10"

3" through 4"	12"
Over 4"	18"

E. Anchorage: Anchor all isolators to the floor, wall or ceiling structure and anchor points reinforced where necessary. Anchor bolts, cap screws, etc., shall not be continuous through the isolator such that vibrations are transmitted to the structure.

F. Adjustment: Adjustable during and after installation, to ensure sufficient clearance between vibration isolation element and rigid restraining device. Do not install isolators until they have been loaded and adjusted to achieve the specified static deflection and clearances.

3.2 EQUIPMENT RESTRAINTS

A. All equipment shall be anchored to resist displacement including sliding, swinging, and overturning due to seismic forces. Friction due to equipment weight shall not be considered as anchorage.

B. Contractor shall submit shop drawings showing seismic restraint design for all equipment required by code to be restrained. Design shall show analysis of supporting structure, anchorages, and restraints in accordance with UBC Section 1630. Analysis shall be as required by the reviewing official.

END OF SECTION

PART 1 – GENERAL

1.1 DESCRIPTION

A. The requirements of this section apply to the insulation of mechanical equipment specified elsewhere in these specifications.

1.2 QUALITY ASSURANCE

A. Insulation Thickness and Thermal Performance: Comply with Chapter 13 provisions of the State of Oregon Structural Specialty Code.

B. Composite (Insulation, Jacket or Facing and Adhesives) Fire and Smoke Hazard Ratings: Not to exceed a flame spread of 25 or smoke development of 50.

C. Component Ratings of Accessories (Adhesives, Mastics, Cements, Tapes, Finishing Cloth for Fittings): Same as "B" requirements above and permanently treated. No water soluble treatments.

1.3 PRODUCT DELIVERY, STORAGE AND HANDLING

A. General: In addition to the requirements specified in Section 15050, the following apply:

1. Deliver insulation, coverings, cements, adhesives and coatings to the site in factory-fabricated containers with the manufacturer's stamp or label affixed showing fire hazard ratings of the products. Store insulation in original wrappings and protect from weather and construction traffic.
2. Protect insulation against dirt, water, chemical and mechanical damage. Do not install damaged insulation. Remove such insulation from project site.

1.4 SUBMITTALS

A. Submit catalog data and performance characteristics for each product specified.

PART 2 – PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Insulating Manufacturers: Schuller, Knauf, Armstrong, Owens-Corning, Pittsburgh Corning, Pabco, Imcoa or Certain Teed. Schuller products are listed unless indicated otherwise.

B. Adhesive Manufacturers: Benjamin Foster, 3M, Insul-Coustic, Borden, Kingco or Armstrong.

2.2 PIPING INSULATION

A. Interior Piping Systems 40 to 850 Deg. F: Glass fiber preformed pipe insulation with a minimum K-value of 0.23 at 75 Deg. F, a minimum density of 3.5 pounds per cubic foot within all-service vapor barrier jacket, vinyl or pre-sized finish and pressure sensitive seal. Schuller "Micro-Lok."

B. Exterior Installations: Same as for interior installations except 0.016" aluminum finish jacket [or, in coastal environments, 0.01" stainless steel]. Schuller "Micro-Lok."

C. Pipe Temperatures Minus 30 to 180 Deg. F: Flexible, preformed, pre-slit, self-sealing elastomeric pipe insulation up to 2-1/8" ID, thermal conductivity of 0.27 BTU/hr. sq. ft./in. at 75 deg. F and vapor transmission rating of 0.2 perms/inch. Apply in thickness necessary to prevent condensation on the surface at 85 deg. F and 70% RH. Armstrong "Armaflex 2000" or, in concealed locations, Imcoa or Nomaco also approved.

D. Pipe Temperatures Up to 1200 Deg. F: High temperature molded calcium silicate insulation with aluminum metal jacket. Furnish with aluminum snap straps. Apply in thickness required for a maximum surface temperature of 120 deg. F at 80 deg. F ambient and for the flow media temperatures. Schuller Thermo-12/Gold.

2.3 DUCT INSULATION

A. Interior Above Grade Ductwork: Glass fiber blanket with "FSK" facing, k value = 0.31 at 75 deg. F, and UL 25/50 surface burning rating. Schuller "Microlite."

B. Below Grade Ductwork: Insulate with foamed-in-place urethane insulation.

C. Exterior Above Grade Ductwork: Glass fiber board with “FSK” facing, 3 pound density, k value of 0.23 at 75 deg. F. Install with 0.016" aluminum jacket. [0.01” stainless steel jacket.] Schuller 800 Series Spin-Glas.

2.4 EQUIPMENT INSULATION

A. Equipment Temperatures Below 70 Deg. F: Flexible, closed cell, elastomeric sheet insulation of 5.5 #/cubic feet density and 0.27 thermal conductivity at 75 deg. F. Armstrong "Armaflex."

B. Equipment Temperatures From 70 to 450 Deg. F: Glass fiber 3 pound density insulation with a 0.23 thermal conductivity at 75 deg. F. Schuller "814 Spin-Glas" with "FSK" jacket or finished as recommended by manufacturer.

C. Equipment Temperatures From 350 to 1200 Deg. F: Molded high temperature calcium silicate minimum 12.5 pound density and 0.4 thermal conductivity at 200 deg. F mean temperature. Glass cloth finish, Claremont Diplag or finished as recommended by insulation manufacturer.

D. Exterior Tanks and Equipment Insulation Covering: Same as interior insulation with weatherproof metal or finished as recommended by insulation manufacturer.

2.5 INSULATION ACCESSORIES

A. Insulation Compounds and Materials: Provide rivets, staples, bands, adhesives, cements, coatings, sealers, welded studs, etc., as recommended by the manufacturers for the insulation and conditions specified.

B. Interior Tanks and Equipment Insulation Covering: Finished metal jacket or as recommended by the manufacturer for insulation material specified.

C. PVC Protective Jacketing and Valve and Pipe Fitting Covers: Schuller Zeston 2000, Proto LoSmoke, or Ceel-Co Ceel-Tite 100 Series with precut fitting fiberglass insulation or approved.

D. Jacket Lap Sealing Adhesives: Foster Drion 85-75 contact cement or approved substitute.

E. Removable/Reusable Insulation Covers:

1. 200 to 600 Deg. F Insulation Filler: Install 2-1/4# - 4#/cu. ft. glass fiber, 6# - 8#/ cu. ft. mineral wool or glass fiber/type E felted (9#/cu. ft.) flexible blankets and pads for large, irregular shaped equipment such as pump casings, bolting flanges, etc. For small common shapes such as valves, elbows, flanges, etc., install preformed flexible glass fiber pipe wrap, preformed glass fiber pipe covering or glass fiber/type E felted (9#/cu. ft.) insulation.
2. 600 - 1000 Deg. F Insulation Filler: Install 4# - 8#/cu. ft. refractory fiber felted, 8# - 10#/ cu. ft. mineral wool or glass fiber/type E felted (9#/cu. ft.) flexible blankets and pads. Install mineral wool pipe wrap, glass fiber/type E felted (9#/cu. ft.), laminated refractory fiber (4# - 6#/cu. ft.) with flexible glass fiber wrap or refractory (ceramic) fiber (6#/cu. ft.) preformed insulation.
3. Over 1000 Deg. F Insulation Filler: Install refractory (ceramic) fiber (6# - 8#/cu. ft.) blanket or pad insulation or 6#/cu. ft. preformed insulation.
4. Encasement, 200 to 600 Deg. F: Glass fiber cloth plain or silicon coated on both sides, knitted stainless steel mesh, glass fiber cloth laminate with aluminum, or stainless steel foil or hex wire mesh.
5. Encasement, 600 to 1000 Deg. F: Glass fiber cloth with stainless or monel wire insertion, knitted stainless steel mesh, ceramic cloth, or glass fiber cloth laminated with stainless steel foil.
6. Encasement, Over 1000 Deg. F: Refractory cloth with nickel or inconel wire insertion, knitted inconel mesh or ceramic cloth with nickel wire insertion.
7. Cold Encasement: Glass fiber cloth silicon coated both sides, knitted stainless steel mesh, glass fiber cloth laminate with aluminum or stainless steel foil or glass fiber cloth with nickel wire insertion, silicon coated both sides.
8. Stitching, 200 to 600 Deg. F: Glass fiber thread/PVC coated, staples - galvanized or stainless steel, galvanized or stainless steel hog rings, 0.010" - 0.15" dia/dead soft stainless steel wire.
9. Stitching, 600 Deg. F: Same as 200 to 600 Deg. F above except no galvanized staples or rings and PVC coated thread to 850 deg. F.
10. Attachments and Securements:
    a. Quilting: Stainless 2-hole washers, both sides with twisted 0.035" - 0.051" wire loops, 12 ga. stainless spindle/washer/ speed clip assembly or stainless 0.035" - 0.051" wire loops.
    b. Lacing and Hooks: Stainless 2-hole 12 gage bent wire lacing hooks, stainless 2-hole dished washer assembly with twisted 0.035" - 0.051" wire loops, 12 gage stainless spindle washer with built-in hook and speed clip or stainless 1-hole dished and flat washer riveted through the cloth.

PART 3 – EXECUTION

3.1 PIPING INSULATION

A. General: Do not insulate underground piping except at joints and fittings on preinsulated piping unless indicated otherwise.

B. Domestic and Chilled Water Piping:

1. Insulate with glass fiber pipe covering, 1” thick for cold water piping and for 1" and smaller hot water piping; 1-1/2" for 1-1/4" and larger hot water piping.
2. At contractor’s option and in accordance with Part 2 of this section, elastomeric insulation may be installed on domestic water piping in thicknesses equivalent to the glass fiber insulation. Installation shall comply with the manufacturer’s recommendation with joints and seams completely sealed. Insulate hot water return piping same as cold water piping.

3. Chilled water piping below grade doesn't require insulation.

C. Waste Lines: Insulate all pipe exposed to outside temperatures with 3/4" thick glass fiber pipe insulation with a vapor barrier jacket.

D. Heating Water Piping: Insulate with glass fiber pipe covering:

Size	Thickness
1/2" to 1-1/2"	1-1/2"
2" to 3"	2"
4" and larger	2-1/2"
Runouts up to 1" and 12' length	1/2"

E. Pipe Fittings:

1. Insulate and finish all fittings including valve bodies, bonnets, unions, flanges and expansion joints with precut fiberglass insulation and preformed PVC covers sealed to adjacent insulation jacket for continuous vapor barrier covering over all fittings.
2. Use 1/2" thick Armaflex or Aerotube foamed plastic at flexible pipe connections on chilled and/or cold water lines. No insulation on other flexible pipe connections.
3. Provide removable/reusable insulation covers on 4" and larger valves, unions, flanges, pump casings, strainers and similar fittings or equipment requiring periodic service.

F. Protective Covering: Install continuous protective PVC or metal covering on all piping and fittings in mechanical rooms, accessible tunnels, enclosed utility trench, attic spaces, accessible ceilings, etc., where insulation may be subject to damage. Install with rivets or cement seams and joints.

G. Piping Insulation Lap Seams and Butt Joints: Install insulation jacket in accordance with manufacturer's. Where jacket joint and lap seams have not adhered, remove affected section of insulation and reinstall or apply lap sealing adhesive in accordance with manufacturer's instructions.

3.2 DUCTWORK INSULATION

A. Ductwork: Insulate the following:

1. All supply ductwork.
2. All supply and return ductwork in systems routed in unconditioned spaces or exposed to the outside conditions.
3. All outside air intake ducts and plenums (exterior insulation).
4. All ductwork required to be insulated by code.
5. All relief ducts inside building envelope which are exposed to outside air temperatures.

B. Insulation Thickness: Select board and blanket insulation of thickness required to provide the following installed R-value.

1. All heating or cooling system supply and return ducts located on the exterior of the building and all outside air intake ducts.
   a. R-5: [All systems, Zone 1]
   b. R-6.5: [Complex system, Zone 2]
   c. R-8: [Simple systems, Zone 2]
2. Ducts located within or below concrete slabs on grade, R-4.
3. All heating and cooling system supply and return ducts located inside of building envelope, R-3.3.

C. Fittings: Wire and duct adhesive as required. To prevent sagging on all rectangular or square ducts over 24" wide, install Gramweld or equal welding pins on the bottom. Maximum spacing 18" on center in both directions.

D. Installation: Applied with butt joints, all seams sealed with vapor seal mastic or taped with 2" wide vapor-proof, pressure-sensitive tape. Seal all penetrations with vapor barrier adhesive.

E. Internally Lined Ductwork: Where internally lined ductwork is indicated on the Drawings and/or specified, no exterior insulation is required. Select duct lining to provide the required R-value. Carefully lap the ends of the exterior insulation a minimum of 6" past the interior insulation unless otherwise shown. Seal the end of vapor barrier jacket to the duct with mastic where the vapor barrier is required. Duct lining is specified in Section 15880.

3.3 EXPANSION JOINTS

A. Insulation: Insulate expansion joints on heating and/or cooling piping to match thickness of adjacent piping. Build up piping insulation adjacent to the expansion joints sufficiently to allow internal clearance within the insulation for the diameter of the expansion joint. Fasten one end of the expansion joint insulation securely and provide aluminum or sheet metal on the built-up insulation at the other end to permit movement of the insulation without damage.

B. Finish: Finish as specified for adjacent piping with fireproof covering.

END OF SECTION

PART 1 - GENERAL

1.1 DESCRIPTION

A. The requirements of this section apply to the fire protection system.

B. Provide all labor and material and perform such other services necessary and reasonably incidental to the design and installation of an automatic sprinkler and standpipe system for all areas indicated on the Drawings and as required by the Governing Agency. Extend the existing system.

1.2 QUALITY ASSURANCE

A. Contractor Qualifications:

1. Established fire protection contractor regularly engaged in the design and installation of automatic fire sprinkler systems.
2. Employ workers experienced and skilled in this trade.
3. System designer: Qualified and certified for the design of fire protection sprinkler systems. NICET level IV technician or Professional Engineer experienced in the design of sprinkler systems.

B. Governing Agency: All work in accordance with and accepted by the following hereafter referred to Governing Agencies:

1. Fire Marshal State of Oregon.
2. City Fire Marshal.

C. Design Requirements:

1. Comply with the latest issue of NFPA Standard 13.
2. Design, lay out and install a hydraulically calculated wet and/or dry pipe system utilizing code approved automatic devices designed particularly for use in this type of system.
3. Fire Sprinkler Coverage: As required by the Governing Agency and including fire protection of all areas including the following:
   a. Kitchen exhaust hood systems.
4. Occupancy Hazard**:** Final Occupancy Hazard designation in accordance with the Governing Agency requirements.
5. Revisions to the Contractor's design required by the Governing Agency shall be at the Contractor's expense.

D. Acceptable Manufacturers: All sprinkler specialty material Grinnell/Gem, Central, Reliable, Globe, Star, Viking, Automatic Sprinkler Corp. of America with UL or FM approval for use in automatic sprinkler systems. All materials and equipment suitable for 175 psi working pressure.

E. Field Wiring: Comply with requirements of Section 15050, Article 1.2, paragraph D, Field Wiring.

F. Work of Other Trades: Comply with requirements of Section 15050, Article 3.1, paragraph D, Coordination.

1.3 SUBMITTALS

A. Working Drawings:

1. Prepare fire protection system working drawing showing locations and types of head or outlets, alarm valves and devices, pipe sizes and cutting lengths, test tees and valves, drain valves, and other related items. Plans shall comply with the requirements of Chapter 8, 1999 NFPA 13, irregardless of the edition adopted by the Governing Agencies and used for design. Plans shall be stamped and signed by the responsible designer. Plans shall be completed using CAD.
2. Provide 3 sets of drawings showing sprinkler head locations and layout coordinated with architectural ceiling details to the Architect for review prior to submitting details to the Governing Agencies.
3. Provide 6 sets of drawings to the Architect to be provided to Insurance Underwriter for approval.
4. Provide 6 sets of drawings to designated representatives of the Fire Marshal for approval.
5. Then provide 6 sets of approved Drawings stamped by the local Fire Marshal of jurisdiction to the Architect for final review.

B. Submittals:

1. Sprinkler Heads: Product Data for each type of head.
2. Alarm flow or pressure switches.
3. Fire department connection.
4. Backflow prevention valve assembly.
5. System control valves.
6. Piping materials.
7. Alarm bell.
8. Air Compressor and air maintenance device.
9. Miscellaneous Equipment.
10. SS Wire Guards @ Gym

C. Test Reports: Submit certificates of completion of tests and inspections.

1.4 EXTRA STOCK

A. Additional Heads: Provide number, type and temperature rating installed as required to meet NFPA 13 requirements.

B. Storage Cabinet: Provide as required to receive reserve sprinkler heads and special installation tools required.

C. Index Label: Provide for each head indicating manufacturer, model, orifice, size or K-factor, and temperature rating. Also provide, inside cabinet, a list of heads stored within and brief description of where installed.

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

A. Miscellaneous Sprinkler Specialties: Complete system including all items required by the Governing Agency including but not limited to:

1. Electric alarm switch and indoor and outdoor alarm bell or water motor gong.
2. Double check assembly.

3. Valve monitoring switches.
4. Fire department hose connections.
5. Wiring from the alarm switches to the point of connection in the Fire Alarm Control Panel. Coordinate with the Electrical Work specified in Division 16.
6. Provide communication equipment with local fire department when required by Governing Agency.
7. Dry pipe air compressor sized and arranged in accordance with the requirements of NFPA No. 13. Include an automatic air pressure maintenance device.

B. Water Service Connection Backflow Preventer:

1. Connect to primary water service with code approved double check valve assembly made up of two brass, internally spring loaded check valves, OS&Y shut-off valves and test cocks.

C. Sprinkler Heads: Approved heads with temperature ratings required for service indicated.

1. Unfinished Areas: Upright, pendent or sidewall spray type, plain bronze.
2. Finished Areas: White recessed and sidewall heads in finished ceilings and where piping is exposed use bronze upright heads.
3. Dry Pipe Systems: Especially designed and approved for dry pipe systems except where piping is routed through heated areas, standard heads may be utilized as approved by the Governing Agency.
4. On-Off Heads: Especially designed and approved. Where shown on the Drawings.

D. Escutcheons: Provide white escutcheons on pipe extending through finished walls and ceilings.

E. Underground Water Piping: Ductile cast iron water pipe; ANSI A-21.51; with mechanical joints, ANSI A-21.10 and ANSI A21.11; and with concrete thrust blocks as detailed on the Drawings.

F. Above Ground Water Piping: Use standard weight (schedule 40)black steel pipe ASTM A53, A135, or A795, and cast iron screwed or mechanical joint fittings especially adapted for sprinkler work. Use reducing fittings where changes in pipe size occur. Bushings are prohibited. All sprinkler specialty material Grinnell, Star, Viking, Automatic Sprinkler Corp. of America or acceptable substitute, with UL approval for the specific use in system. No grooved fittings are permitted in inaccessible areas.

G. At Contractor's option, thin-wall steel pipe ASTM A135 or ASTM A795, and mechanical joint fittings specifically approved for sprinkler work, may be substituted for the black steel pipe specified above. Thin-wall pipe must have a CRR of 1.00 or greater. This option is available only in exposed areas.

H. At contractor' option, thin wall threadable steel pipe, ASTM A135 or A795, and cast iron or malleable iron screwed fittings 1½" and smaller, approved for sprinkler work.

I. Valves: UL and/or FM listed for fire protection service.

1. Iron body OS&Y pattern, bronze mounted double disc, parallel seat.
2. Iron body butterfly style with EPDM liner, bronze disc with lever or indicating type gear operator.
3. Bronze body ball valve, three-piece design, with approved operator.
4. Where required by Governing Agency, provide wall or post style indicating valves.

J. Valve Monitoring Switches: Provide approved monitoring switches where shown on the Drawings or required by Governing Agency. In vaults and other areas where flooding conditions may occur, provide submersible type switches.

K. Stainless Steel Wire Guards: Standard manufacture. (Required on Gymnasium heads)

L. Fire Department Connection: By civil engineering firm. See civil drawings.

M. Fire Hydrant: Approved by Underwriters Laboratories and Associated Factory Mutual Fire Insurance Companies and constructed in accordance with AWWA standard specifications for 5" base valve hydrants. Arrangement as shown on Drawings. Provide two 2-1/2" hose connections and a steamer connection with threads to match existing fire district equipment. Mueller, M & H, Zurn, Kennedy acceptable substitute.

N. Fire Extinguisher Cabinet: Cold rolled enameled steel cabinet with duo-panel door, recessed, semi-recessed type as required by location. Furnish less extinguisher. Allenco 285AKD, Elkhart C-950 acceptable substitutes.

O. Fire Hose Cabinet: UL approved 2-1/2" X 1-1/2" valve and hose rack with 75 feet of unlined hose and Lexan fog nozzle in cold rolled steel cabinet with break-glass in piano hinged door. Standard, Seco, Allenco, and Potter-Roemer acceptable substitutes.

P. Fire Hose Reel: UL and/or FM. approved hose reel with wall or pipe mounting bracket, 100 feet of lined 1-1/2" hose, angle valve, hose coupler, and brass nozzle. Standard, Seco, Allenco, and Potter-Roemer acceptable substitute.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Connect to water supply source as shown on Drawings, check adequacy and call any deficiency to attention of Architect. Coordinate with work in Section 15050.

B. Install all piping in a true and even manner with lines pitched for drainage and system arranged so that it can be entirely emptied of water. Install hangers at all branch line connections to cross mains and at all other points as required in herein before specified Underwriters Laboratories, Inc. and NFPA standards.

C. Support all pipe work from building construction with mild steel hangers spaced not more than 12 feet on centers. Support mains independently of branches and in no case shall branch hangers assume any portion of the weight of mains.

D. Locate sprinkler heads in repeating, modular pattern, centered and accurately coordinated with ceiling grid as indicated. Conceal all piping unless indicated otherwise. Coordinate design with lighting and exposed HVAC duct layout in areas without ceilings.

E. Locate and install the required fire sprinkler alarm, flow, and test and drain valves where required by the Governing Agency.

F. Where sprinkler lines penetrate fire rated partitions, provide fire stopping system in accordance with Section 15050.

G. Provide stainless steel wire guards over heads at all areas where heads are exposed to abuse (i.e. gymnasium, mechanical rooms, etc.) and where required by the local Fire Marshal.

H. No mechanical grooved fittings shall be used in concealed inaccessible areas.

I. Where sprinkler lines penetrate sound walls, seal all openings with Acoustic Sealant.

3.2 TEST

A. Test all pipes to a hydrostatic pressure of 200 psi and maintain for four hours minimum. Perform other tests as directed by Governing Agency.

3.3 PAINT

A. Paint all exposed piping and hangers in accordance with Section 09900. Do not paint heads.

3.4 CERTIFICATE OF COMPLETION

A. Obtain and deliver to Owner a certificate, in duplicate, stating that system as installed has been inspected and accepted by authorities and/or agencies having jurisdiction, and that all regulations affecting work have been satisfied. Submit an acceptable certificate to the Owner before final payment is requested.

B. Certificate: Minimum NFPA Form 8-1 information per NFPA 13.

3.5 EXTERIOR HEADS

A. All exterior heads shall be fitted with guards.

3.6 GLYCOL SYSTEMS

A. No glycol systems permitted. Only dry pipe systems accepted.

END OF SECTION

PART 1 - GENERAL

1.1 DESCRIPTION

A. Provide and install underground distribution gas line to 5 feet outside of building. Size and location as shown on Drawings.

1.2 QUALITY ASSURANCE

A Installation contractor shall be experienced and employ Northwest Natural Gas Co. certified installation personnel.

1.3 WORK IN OTHER SECTIONS

A. Utility Trenching, Backfilling and Compacting; Section 15050.

1.4 PROJECT CONDITIONS

A. Protect existing site improvements from damage during installation of gas lines.

B. Schedule work to prevent trenching through new paved areas.

C. Pipe fusing machine may be furnished by the Owner for use by the contractor. Use of the machine shall be scheduled and agreed upon in writing.

1.5 REFERENCES

A. "Regulations for the Transportation of Natural and Other Gas by Pipeline: Minimum Federal Safety Standards," Title 49 of the code of Federal Regulations, Materials Transportation Bureau, Department of Transportation.

1.6 LIMITATIONS

A. PE 2406 gas pipe installation is limited to below-ground installation, outside of structures, and between -20 degrees Fahrenheit and 100 degrees Fahrenheit ambient temperature.

B. Exercise care to prevent incompatible materials such as mastics, primers, adhesives, etc., from coming in contact with the PE material. Adhesive tapes shall not be used on PE pipe at any time.

C. PE pipe shall not be installed within 12" of an underground power line.

PART 2 - PRODUCTS

2.1 MATERIALS

A. All pipe and fittings shall be polyethylene (PE) 2406 meeting ASTM D2513. Fittings and joining procedures shall be compatible with the piping material specified. Curb cocks shall be polyethylene.

B. Tracer Wire: Not less than 14 gauge single strand, copper wire with orange colored insulating coating.

PART 3 - EXECUTION

3.1 PREPARATION

A. Excavation: Minimum bury 30". Trench size as required for installation, inspection and backfill compaction. See Section 02200, Earthwork.

B. Backfill bottom 12" of the trench with sand for bedding so as to provide continuous support for the pipe. Rocks, gravel, and other debris shall not be used.

C. All PE pipe shall be field inspected for damage prior to installation. Any pipe found to have a cut, gouge, or dent with a depth exceeding 10% of the wall thickness shall be rejected.

3.2 INSTALLATION

A. Install PE gas lines in size and location indicated on Drawings.

B. PE pipe shall be snaked on the trench bottom and allowed to stabilize to ground temperature (approximately 30 minutes) prior to final tie-in.

C. Fusion procedures used shall be in accordance with the manufacturer's recommended procedures and meet the specification as set forth in the "Minimum Federal Safety Standards," Paragraph 192.283. See Section "REFERENCES."

D. Protection of Material and Components: Pipe and tube openings shall be closed with caps or plugs during installation. Equipment shall be protected from dirt, water, and chemical or mechanical injury. At the completion of all work, the entire system shall be thoroughly cleaned.

E. Liquid odorant shall not be introduced into PE pipelines.

F. Trench compaction is required under paved areas. Compaction shall be by hand-held compactors. Hydrahammers shall not be used. Wheel rolling for trench compaction can be used only after the trench has received its final lift. Care must be taken when compacting around joints and valves to insure well-compacted support and to protect the pipe and valves from excessive torsional and shearing loads.

G. Tracer wire shall be placed in the trench as close as practical to the PE pipe. Tracer wire shall be accessible at grade via all services, valve boxes or curb cocks. All joints in tracer wire shall be spliced/connected by Cadweld, self stripping connectors, or crimp connectors and coated with an electrical mastic and wrapped with an electrical tape.

3.3 TESTING

A. PE pipe test pressure shall not exceed 3 times the maximum design pressure of the pipe nor shall the temperature of the PE exceed 100 degrees Fahrenheit during testing.

B. Testing shall not start until temperature and pressure stabilization occurs (approximately 30 minutes after the pipe has been placed in trench).

C. Test line for 100 psig test pressure for a duration of 5 minutes per 100 feet of length but not less than 30 minutes.

D. Repair piping sections which fail testing by disassembly and reinstallation, using new materials as required to prevent leakage. Do not use solder, mastics, or other temporary repair methods.

END OF SECTION

PART 1 - GENERAL

1.1 DESCRIPTION

A. The requirements of this section apply to the plumbing system.

B. Provide fixtures specified and shown on the Drawings.

1.2 QUALITY ASSURANCE

A. Code: Comply with requirements of the Oregon State Plumbing Specialty Code.

B. Fixture color: White unless indicated otherwise.

C. Utility Connections: Make utility and equipment connections and install distribution piping as shown on the Drawings and specified herein. Verify size, location, depth, elevation and arrangement of connection points before bidding or starting work.

D. Potable Water Valves: Potable water valves not limited to faucets, mixing valves, or pressure reducing valves. Valves shall meet NSF Standard 61, Section 9, for drinking water faucets and shall be brass construction. Brass components which contact water within the faucet shall be from brass which contains no more than 3 percent lead by dry weight.

E. Field Wiring: Comply with requirements of Section 15050, Article 1.2, paragraph D.

PART 2 - PRODUCTS

2.1 PIPING

A. Piping, fittings, and related items as specified in related Sections 15060, 15100 and 15250.

2.2 SITE WORK MATERIALS

A. Excavation and Backfill: As required in Section 15050.

2.3 INTERIOR PLUMBING MATERIALS

A. Cleanouts:

1. Manufacturer: J.R. Smith, Zurn, Wade, Ancon, or approved substitute.
2. Types:
   a. Tile Floor Cleanouts: Smith 4053-U with square heavy-duty nickel bronze top, taper thread, bronze plug, and vandalproof screws.
   b. Carpeted Floor Cleanout: Smith 4023-U-X with round heavy-duty nickel bronze top, taper thread, bronze plug, carpet clamping device, and vandalproof screws.
   c. Concrete Floor Cleanout: Smith 4023 with round heavy-duty nickel bronze top.
   d. Wall Cleanouts: Smith 4472-U, bronze ferrule with raised head bronze plug, stainless steel shallow cover and vandalproof screws.
   e. Outside Area Walks and Drives: Smith 4253-U-G with galvanized cast iron body, top secured with vandalproof screws, taper thread and bronze plug. Install in 18” x 18” x 6” deep concrete pad flush with grade.

B. Flashing: Minimum 4# sheet lead; to extend horizontally 10” from edge of vent penetrations or rain drain body and vertically 12” minimum up from roof turned over and down into hub of vent or finished with bronze cap providing counterflashing for screwed pipe.

C. Downspout Boot: Smith No. 1787-12, 4” diameter by 18”, offset type. Smith No. 1785 or 1786 for rectangular downspouts.

D. Air Chambers and Shock Arrester: Precharged bellows or sealed piston type manufactured to meet PDI WH-201 and ASSE 1010 Standards. Size in accordance with PDI procedures. J. R. Smith, PPP, Sioux Chief, Wade, Zurn, Ancon, or approved substitute.

E. Priming Valves: Smith 2699, Wade W8800T, Zurn Z1022, Ancon MS810 or equivalent Precision Plumbing. Locate in closets, under counters or in walls behind Milcor or access panels as specified in Section 15050. Use copper specified in Section 15060, Pipe & Pipe Fittings, for all underground priming lines. An adequate head of water to make the primer work must be provided for each. Provide service valves and unions to permit service.

F. Traps: Except chrome plated fixture traps. Recessed drainage pattern for threaded pipe and same grade as pipe for cast iron pipe; with cleanout plugs in trap body in all above grade locations.

G. Domestic Hot Water Circulator: Bronze body, bronze fitted, in-line circulator with sleeve bearing. Bell & Gossett 1” HV or equivalent Grundfos, Thrush, Taco, or Armstrong. Unit to start with Building Automation System subject to Aquastat.

H. Pressure Reducing Valve: Single seat type with renewable stainless steel seat and valve. Size and capacity as shown on Drawings. Bronze bodies with screwed connections on valves 2-1/2” and smaller and flanged steel bodies on valves 3” and larger. Install each PRV with strainer on inlet or internal strainer. Leslie, Spence, Fisher, Watts, Foster, Cash-Acme, Zurn-Wilkins, or approved substitute.

I. Backflow Preventer: Where indicated on the Drawings, install a reduced pressure backflow preventer complete with shutoff valves, two separate check valves, differential relief valve, and test cocks. USC Foundation for Cross Connection Control, State Health Officials, and serving utility approved. Bronze bodies on units 2” and smaller, and cast iron bodies with bronze trim on units 2-1/2” and larger.

J. Dishwasher and Cooking Equipment Pressure Reducing Valve: For installation with dishwasher booster heater and other kitchen equipment, all brass, single seat type for dead end service, with renewable stainless steel seat and valve. Designed for service on hot water to reduce pressure from 50 psi to 20 psi. Leslie, Watts, Fisher, Spencer, Cash-Acme, McAlear, or approved substitute.

K. Master Mixing Valve: All brass or bronze body with stainless steel parts, thermostatic master control element to fail safe upon cold water or control element failure. Provide with external union angle check stops, strainers, volume control, shutoff valves, dial thermometer. Valve location, arrangement and capacity as shown on plans. Symmons Leonard, Lawler, Powers approved. Unit shall be provided as assembly in concealed box.

L. Gas Pressure Regulators: Size based on pressures indicated on the drawings and for 1.5 times connected load. Style and model as approved by serving utility. Maxitrol, Rockwell, Fisher, Reliance, or approved substitute.

M. Domestic Water Balancing Valve: Balancing valves shall be pressure independent, constant flow as scheduled on the plans. Units shall be approved for domestic water usage.

N. Pressure-Temperature Test Plugs:

1. ¼" or ½" NPT fitting of solid brass capable of receiving either an 1/8" OD pressure or temperature probe and rated for zero leakage from vacuum to 1000 psig. Neoprene valve core for temperatures to 200 deg. F., Nordel to 350 deg. F.
2. Provide for each test plug a pressure gauge adapter with 1/16" or 1/8" OD pressure probe.
3. Furnish a test kit containing one 2-1/2" dial pressure test gauge of suitable range, one gauge adapter with 1/16" or 1/8" OD probe and two 5" stem pocket test thermometers – one 0 to 220 degrees F and one 50 to 550 degrees F. Turn the kit over to the Architect.
4. Cisco "P/T Plugs," Peterson "Pete's Plug" or approved substitute.

O. Thermometers: Mercury-in-glass, adjustable stem, separable sockets, plus 40 to 240 degrees F range (unless indicated otherwise). Weiss numbers are listed. Equivalent Taylor, Trerice, Weksler or approved substitute.

1. Wide case (9") in equipment rooms and all major equipment items. Weiss "9VS" series.
2. Narrow case (7") in all other locations. Weiss "7VS" series.

P. Pressure Gauges: Install on suction and discharge of all pumps and where shown on Drawings 4-1/2" dial, 0-100 psig graduation pressure gauges with Ashcroft No. 1106 pulsation dampers and stop cocks. Weiss UGE-1 or equivalent Ashcroft, Marsh, Trerice, Weksler.

2.4 PLUMBING FIXTURES

A. Stops: Furnish stop valves for all fixtures. Screwdriver style, in wall, angle or straight through pattern to fit installation. Stops to be all brass with full turn brass stem and replaceable washer, no plastic. Compression nuts to be high copper content brass. Finish to be copper nickel chrome plate. Product to carry manufacturer's name. Risers to be chrome plated copper. McGuire, Chicago, Brasskraft, or approved substitute.

B. Provide handicap piping protector kit on all exposed accessible fixture traps and supplies (I&S Insulation Co. Inc., Brocar Products Inc. kit 500R, McGuire "Prowrap", Plumberex "Pro-2000" or approved substitute.

C. 1.28 Gallon Flush Water Closet, Vitreous China: Water closet bowl shall be designed for 1.28 gallon siphon jet flushing action.

1. Install each listed water closet with the following:
   a. Flush Valve: Quiet acting, 1.28 gallon/flush valve with ADA metal oscillating non-hold-open handle, plated brass, screwdriver check/control stop with vandal resistant cap, cast wall flange, synthetic rubber diaphragm, and vacuum breaker, as recommended by closet manufacturer. Sloan or approved.
   b. Seat: Solid white molded plastic seat; open front less cover for elongated bowl with check and self-sustaining hinge. Olsonite 10CC-SS, Beneke 523-SS/CH-B, Bemis 1955 SS/C or Church 5334.171 (295-SS).
2. Floor Mount "WC-1": Zurn, Jay R. Smith, Ancon, and Wade. Kohler 4350 or equal American Standard, Eljer.
3. Floor Mounted, Top Spud 18" High "WC-2" and "WC-3": Kohler K-4368 or equal Zurn, American Standard, Eljer.

D. Urinal, Flush Valve, Vitreous China, "UR-1", "UR-2":

1. Install each listed urinal with the following: Quiet acting, exposed chrome plated brass flush valve, screwdriver check/control stop with vandal resistant cap, cast wall flange, synthetic rubber diaphragm, and vacuum breaker, as recommended by fixture manufacturer. Sloan.
2. Stall Type: Install with universal beehive strainer grid. American Standard 6400.014, Kohler K-4920-T, or Eljer 161-1000. Provide with seam covers where indicated on Architectural Drawings.

E Lavatory, Vitreous China:

1. Counter Mounted, Self-rimming, Oval "LV-1": Install with Chicago 2200 faucet. American Standard 0476.028, Kohler K-2196, or Eljer 051-3514.
2. Counter Mounted, Self-rimming, Oval "LV-2": Install with chrome plated brass body with handle for the handicapped, vandal resistant 0.5 gpm aerator, temperature limit stop, and grid strainer waste. Install with Chicago 2200 faucet. American Standard 0476.028, Kohler K-2196, or Eljer 051-3514.
3. Wall Hung, 20” x 18” Size, “LV-3”: Provide with concealed arm hangers and wall backing plate (J.R. Smith, Josam, Wade, Watts or Zurn). Install with chrome plated brass body with handle for the handicapped, vandal resistant 0.5 gpm aerator, temperature limit stop, and grid strainer waste. Install with Chicago 2200 faucet. American Standard 0355.012, Kohler K-2005, or Eljer 051-2104.

F. Service Sump (Mop Basin) "SS-1":

1. Faucet exposed, rough plated, long spout, top brace, hose end spout with bucket hook, vacuum breaker and integral stops in shanks. Chicago 897, T & S B-0665-BSTP, or equal Zurn, Delta Commercial, mounted 24" above rim. Install with 18 gauge type 302, No. 4 finish stainless steel splash on the two walls.
2. Molded stone 24" x 24" x 10" deep room corner type with vinyl bumper guard and 3" strainer outlet. Fiat, Mustee, Swan or approved substitute.

G. Drinking Fountains:

1. "DF-1": Double face mount, stainless steel with one fountain mounted and equipped for the handicapped. Provide with vandal resistant cover plate. Western (round) 4343-WC, Halsey Taylor (rect.) HT-ESBP, Haws (round) 1119, Haws (rect.) 1104, Elkay (rect.) EDFP-17C.
2. “DF-2”: Stainless steel face mounted exterior mounted, with freeze proof, and vandal resistant options. Set at height to meet ADA. Elkay Model EDFP210FPK series or equal.

H. Drains:

1. Zurn, Jay R. Smith, Wade and Ancon. Numbers scheduled on drawings represent minimum acceptable standard for locations involved.
2. Install 4 pound sheet lead flashing, extending not less than 10" from and clamped to all drains not completely cast-in-place in a homogeneous material.

I. Hose Bibs:

1. Outside "HB-1": Non-freeze type with vacuum breaker, bronze wall casing and wall clamp. Zurn Z-1310-6, Wade W-8620, Woodford 65 series, Smith 5609-PB, or Ancon HY420.

J. Sink, Classroom, "CS-1":

1. Single compartment, 18 gauge stainless steel counter top, 31" x 19" size, ADA compliant.
2. Manufacturers: Elkay DRKAD3119, Haws 4230 Series, Halsey Taylor 7880, Western 1931 SS.
3. 1-1/2" chrome plated cast brass "P" trap and stainless steel strainer outlet. Chicago 895 faucet with 1.5 GPM E35JKCP aerator. Hot and cold double pantry faucet with 1.5 gpm aerator self-closing angle stream anti-squirt bubbler with volume regulator, Chicago 748-665CP. All trim shall be vandalproof. Western, Haws, Chicago or approved substitute.

K. Stainless Steel Sinks:

1. Type 302 or 304, 18 gauge, self-rimming stainless steel sink, fully undercoated, drawn bowl with satin finish. Elkay numbers are listed; or approved substitute. Install with stainless steel crumb cup strainer outlet, flange tail piece, and 1-1/2” trap; Elkay, Keeney, or approved. For faucets, Chicago numbers are listed.
2. Single Compartment "S-1": Install with Chicago 1201 with E35JKCP aerator or T & S faucet with 1.5 gpm aerator. Elkay LRAD 2222. Install with 1/2 HP garbage disposal. ISE 333SS, Waste King SS-2600, Kitchenaid KWC-200C or approved substitute.
3. Double Compartment “S-2”: Install with Chicago 1201 with E35JKCP aerator or T & S faucet with 1.5 gpm aerator. Elkay LRAD 332165. Install with instant hot water dispenser IN SINK ERATOR F-GN1100 or approved.
4. Double Compartment “S-3”: Same as S-2 less garbage disposal.
5. Single Compartment, “S-4”: Install with Chicago 1201 faucet. Elkay LRAD 222265.
6. Wall Hung, “S-5”: Install with Chicago 305-RCP faucet. Elkay CHS 1716.

L. Single Stall Shower, "SH-1": Install with concealed piping and 2.5 gpm head. Pressure equalizing mixing valve with combination strainer/check stops and temperature limit stop. Delta, Moen, Symmons 1-100 or approved equal. Fiberglass shower stall with grid strainer outlet, grab bars and curtain rod reinforced for grab bar, curtain rod and pre-installed fold down seat, ADA approved. FiberFab 38H1 or approved equal.or equal Aquaglass, Lasco, Aquarius.

M. Clothes Washer Fitting, “CW-1”: Acorn 8185, Guy Gray WB 200 / T 200 hot and cold water valve washing machine waste outlet.

N. Fixtures Furnished by Owner (and/or Under Another Section): Some fixtures will be furnished by the Owner (and/or under another specification section). Include under this section the required rough-ins, 3/8" chrome plated supplies with screwdriver stops, 1-1/2" chrome plated cast brass "P" trap (or, on kitchen sinks, 2" cast iron "P" traps) for each sink compartment, and make final connection. Verify all rough-ins and connection requirements before commencing work.

PART 3 – EXECUTION

3.1 UTILITY SERVICE

A. Plumbing Utility Connections: Complete installation. Contact local serving utilities to determine conditions involved and make or arrange to have connection made at proper time and pay all costs involved.

B. Sanitary and Storm Sewers: Connect to or arrange for connection to public sanitary and storm sewers as shown on the Drawings and as required by the serving utility. Verify depth, size and location prior to installation of the new sewer systems.

C. Water Service: Connect to or arrange for connection to public water service. Verify serving utility requirements prior to beginning any installation. Verify water main size, depth, pressure and location prior to starting work.

D. Fire Service: Connect to or arrange for connection to existing public water main. Contact local serving utilities to determine conditions involved and make or arrange to have connection made at proper time and pay all costs involved.
Provide vault and install backflow preventer provided under the fire sprinkler work specified in Section 15300. Coordinate vault size and piping arrangement.

3.2 GAS SERVICE

A. Contact gas company service as required and pay all costs involved. Run all gas distribution piping and make final connections to all gas using equipment. Install regulators to deliver proper inlet pressures and vent regulators to outside where required.

3.3 EXCAVATION AND BACKFILL

A. As specified in Section 15060.

3.4 PIPING

A. Install in accordance with Section 15060, 15090, 15100 and 15250.

B. Shock Arrestors and Air Chambers: Install at end of mains, in a battery of three or more flush valve-operated fixtures water header, ahead of quick closing and solenoid operated valves. Size per PDI recommendations where size is not indicated. Provide access panels.

C. Trap Priming: Precision plumbing PR-500, J.R. Smith 2699, Wade W8800T, Zurn Z1022 or Ancon MS810. Locate in closets, under counters or in walls behind Milcor or access panels as specified in section 15050. Use copper specified in section 15060, pipe and fittings, for all underground priming valves.

3.5 CLEANOUTS

A. Where required by code, at each change of sewer direction 45 degrees or greater and more than 10’ long, at end of each branch or main and spaced not greater than 100’ apart, as required by code and/or as shown on Drawings.

3.6 FIXTURE INSTALLATION AND CONNECTION

A. All exposed fixture connections and piping shall be plated with polished chrome. Where chair carriers or special carrier design are not indicated, provide 3/16” thick by 6” wide steel to waste or vent piping and to available building construction.

B. All fixtures in contact with finished walls shall be caulked with waterproof, white, non-hardening sealant which will not crack, shrink or change color with age.

C. All fixtures and component parts shall conform to governing codes.

3.7 FIXTURE CLEANING

A. Remove construction protection, tags and labels and thoroughly clean all plumbing equipment and trim scour all fixtures just prior to building acceptance.

END OF SECTION

PART 1 - GENERAL

1.1 DESCRIPTION

A. The requirements of this section apply to the Heating, Ventilating and Air Conditioning systems.

1.2 SUBMITTALS

A. Submit in accordance with Section 01330, Submittals.

B. Submit catalog data, construction details, performance characteristics for each type and size of heat generation equipment.

C. Submit operating and maintenance data.

1.3 QUALITY ASSURANCE

A. Ratings:

1. Air Handling Equipment: AMCA rated and labeled.
2. Air Conditioning and Refrigeration Equipment: ARI certified and ARI labeled.

B. Codes: Comply with applicable sections of the State Mechanical Specialty Code.

C. Field Wiring: Comply with requirements of Section 15050.

PART 2 - PRODUCTS

2.1 HEATING AND CHILLED WATER

A. Pressurized Precharged Expansion Tank: Precharged diaphragm type hydropneumatic tank with all necessary air elimination fittings. Install with ball valve on piping connection. Taco only. No substitutes. .Provide isolation valve for tank. Add pressure gauge and air side and water inlet.

B. Air Vents: Install at all system high points whether shown or not; fabricate of 2" diameter or larger pipe at least 12" long. At the high point of each main install an Armstrong No. 1AV autovent, or equivalent Taco, Bell & Gossett, Armstrong, Dunham-Bush approved substitute.

C. In-Line Circulators: Pipe mounted, in-line arrangement with mechanical seals with ceramic seal seats, suitable for continuous operation at 225 deg. F at head and capacity stated on Drawings. Cast iron impeller casing, oil lubricated bronze journal and thrust bearings or regreasable ball bearings (manufacturer's standard), 1750 rpm standard frame motor. Impeller size not to exceed 90% of largest diameter impeller which will fit pump casing. Minimum horsepower as indicated on Drawings and not less than will be required at any point of the impeller curve. Provide pressure gauge tappings on suction and discharge flanges. Taco only with no substitutes. .

D. Triple Duty Valve: Combination spring loaded vertical check, calibrated balancing and shut off valve with balance point memory in angle or straight pattern as required or as shown on the Drawings. Bell & Gossett, Taco, Armstrong, Thrush, Victaulic, Wheatley or approved substitute.

E. Air Separators: Bell & Gossett, Thrush, Taco, Armstrong, Dunham-Bush, Wheatley or approved substitute with internal strainer.

F. Thermometers:

1. Mercury-in-glass, adjustable brass stem, separable sockets, aluminum case, plus 40 to 240 deg. F range (unless indicated otherwise) thermometers. Weiss, Taylor, Trerice, Weksler or approved substitute. Provide well for each thermometer.
2. 9" in equipment rooms and all major equipment items. Trerice A405.
3. 7" in all other locations. Trerice A401.

G. Pressure Gauges: Install on discharge of all pumps and where shown on Drawings 4-1/2" dial, pressure gauges plus or minus 1% accuracy at midrange. Trerice 600C or equivalent, Weiss, Ashcroft, Marsh, Weksler. Provide siphons on steam gauges and snubbers on systems with pressure pulsations. Select gauge range to operate in middle third of scale. Provide compound gauges at pump suction.

H. Pressure-Temperature Test Plugs:

1. 1/4" or 1/2" NPT fitting of solid brass capable of receiving either an 1/8" OD pressure or temperature probe and rated for zero leakage from vacuum to 500 psig. Neoprene valve core for temperatures to 200 deg. F, Nordel to 350 deg. F. Provide each test plug with a pressure gauge adapter with 1/16" or 1/8" OD pressure probe.
2. Furnish a test kit containing one 2-1/2" dial pressure test gauge of suitable range, one gauge adapter with 1/16" or 1/8" OD probe and two 5" stem pocket test thermometers - one 0 to 125 deg. F and one 50 to 250 deg. F. Turn the kit over to the Architect. The system balancing firm may use this kit to complete the balancing.
3. Sisco "P/T Plugs," Peterson "Pete's Plug," Trerice “Test Plugs,” or approved substitute.

I. Suction Diffusers: Where indicated on Drawings provide a suction diffuser with inlet vanes, combination diffuser-strainer orifice cylinder and temporary start-up strainer on the inlet of base mounted pumps. Bell & Gossett, Taco, Armstrong, Thrush, Victaulic, Wheatley or approved substitute.

J. Strainers: "Y-pattern," iron bronze body rated for pressures indicated with blow-off connection and 20 mesh stainless steel screen.

K. Flow Indicators: Install, where shown on plans, flow indicating orifice or venturi fittings complete with quick disconnect meter valves, size and series identification tags. Install as recommended by manufacturer. Barco, Taco, Venturi Meter Co, Bell & Gossett, Thrush, Armstrong or approved substitute.

L. Circuit Setter and Balancing Valves: Balancing fitting with differential pressure taps, brass or bronze body and trim. Bell & Gossett "Circuit Setter" or equivalent Tour & Andersson, Taco, Armstrong, Flowset, Thrush, Wheatley or approved substitute. At contractor's option, balancing valves 3" and larger may be butterfly style valves.

M. Chemical Shot Feeder: 2 gallon feeder rated for 125 psi working pressure complete with fill funnel and valve or cap, drain valve, air vent, and inlet and outlet connections. Mogul, J.L. Wingert, or approved.

PART 3 - EXECUTION

3.1 PIPING INSTALLATION

A. Refer to applicable Sections for Piping, Valves, Insulation, Painting, etc.

3.2 EQUIPMENT INSTALLATION

A. Installation and Arrangement: Install and arrange as shown on the Drawings. Comply with manufacturer's recommendations for installation connections and start-up.

B. Lubrication: Lubricate all moving and rotating parts in accordance with the manufacturer's recommendations prior to start-up.

C. Air Vents: Conduct 1/4" copper tubing from high end of air chambers to accessible locations and terminate with screwdriver cock. Conduct 1/4" copper tubing from outlets of automatic air vents to floor drains indicated or to the outside when approved by Governing Authorities and Architect.

D. Pumps: Mount in a manner to allow disassembly of pump and motor without disturbing piping.

END OF SECTION

PART 1 - GENERAL

1.1 SCOPE

A. The work to be performed includes all new equipment, labor and materials required to furnish and install high-efficiency Pulse hydronic boilers as described in this specification.

1.2 REFERENCES

A. ASME Section IV.
B. ASME CSD1 - Controls and Safety Devices.
C. ANSI Z21.13.
D. CSA - CGA/AGA
E. GE GAP
F. NEC - National Electrical Code

1.3 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data, including rated capacities of selected model, weights (shipping, installed, and operating), installation and start-up instructions, along with furnished accessory information.

B. Shop Drawings: Submit manufacturer's assembly-type shop drawings indicating dimensions, weight loadings, required clearances, and methods of assembly of components.

C. Wiring Diagrams: Submit manufacturer's electrical requirements for boilers including ladder-type wiring diagrams for interlock and control wiring. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed.

1.4 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Firms regularly engaged in the manufacturing of pulse combustion, high efficiency, condensing boilers, of types and sizes required, whose products have been in satisfactory use in similar service for not less than 10 years.

B. The hot water boiler maximum working pressure will be 160 psig.

C. Pulse Boiler Flame Safeguard Control will be of an accepted quality manufacturer bearing UL Certification.

D. The entire boiler system and its installation shall conform to the manufacturer's instructions, applicable codes and associated National Board requirements.

E. The equipment shall, as a minimum, be in strict compliance with the requirements of this specification and shall be the manufacturer's standard commercial product unless specified otherwise. Additional equipment features, details, accessories, etc. which are not specifically identified but which are a part of the manufacturer's standard commercial product, shall be included in the equipment being furnished.

F. The equipment shall be of the type, design, and size that the manufacturer currently offers for sale and appears in the manufacturer's current catalog.

G. The equipment shall fit within the allocated space, leaving ample allowance for maintenance and inspection.

H. The equipment shall be new and fabricated from new materials. The equipment shall be free from defects in materials and workmanship.

I. All units of the same classification shall be identical to the extent necessary to ensure interchangeability of parts, assemblies, accessories, and space parts wherever possible.

J. In order to provide unit responsibility for the specified capacities, efficiencies, and performance, the boiler manufacturer shall certify in writing that the equipment being submitted shall perform as specified.

1.5 WARRANTY

A. Boiler manufacturer shall guarantee in writing equipment to be free of defects for one year after start-up date or 18 months from factory shipment, and to repair or replace at manufacturer's expense any defective parts. Unit shall receive such factory tests as are deemed advisable by the manufacturer to check construction and operation.

B. The pressure vessel shall be guaranteed against thermal shock for 10 years when utilized in a closed loop hydronic heating system with a maximum temperature differential rating of up to 170 °F. The boiler pressure vessel shall be guaranteed accordingly without a minimum flow rate or return water temperature requirement. The boiler shall not require the use of flow switches or other devices to ensure minimum flow.

C. The pressure vessel shall carry a 10-year warranty against material and workmanship defects.

D. The combustor and exhaust pipes (heat exchanger) shall be guaranteed against flue gas corrosion for a period of 10 years for carbon steel boilers and a period of 5 years for stainless steel boilers.

E. All parts not covered by the above warranties shall carry a one-year warranty. This shall include all electrical and burner components.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. This Specification is based on products as manufactured by Fulton Heating Solutions, Inc, Pulse QT Series. Equivalent units and manufacturers will be considered upon prior approval.

B. Basis of Design: Fulton Heating Solutions Inc, Model PHW-1000QT, PHW-1400QT or PHW-2000QT.

2.2 BOILER CONSTRUCTION

A. The exhaust decoupler shall be constructed of ¾" corrosion resistant Corten and include a flue gas condensate drain.

B. The combustor shall be constructed of SA-53B ERW pipe.

C. The pressure vessel shell shall be SA-53B ERW pipe or SA-285 Grade C plate. The heads shall be SA-516 Grade 70 plate. The pressure vessel shall be fully insulated with 2" of high temperature insulation.

D. The pulse combustor location shall be such that all combustor assembly components are located within water-backed areas.

E. The boiler's pressure vessel, combustor, and exhaust decoupler shall be encased in an 18 gauge metal cabinet with primer and finish coat of paint.

F. Boilers utilizing copper heat exchanger construction are not acceptable.

2.3 BOILER DESIGN

A. Boiler shall be fire-tube design, utilizing the principles of pulse combustion. The boiler shall be self-aspirating and require no forced or induced draft fan to supply air for combustion after ignition.

B. Boiler shall have a noise level of less than 65 dbA when measured within five feet of the respective boiler's front, back, left and right sides and within three feet of the intake and exhaust connections. Sound levels are based on assumed environmental noise conditions.

C. External convection and radiation heat losses to the boiler room from the boiler shall be less than 0.5% of the rated boiler input. The boiler shall not contain any refractory, refractory lining or ceramic in the furnace or firebox.

D. The boiler shall be designed for operation in a condensing mode, in order to extract the latent heat from the combustion products. The boiler shall have a minimum acceptable fuel-to-water efficiency of 91% at a return water temperature of 80 °F and at the full rated input capacity of the boiler. Overall efficiency at the low fire rated input capacity will be 98%.

E. The boiler shall be able to operate without the use of a 3-way valves or primary/secondary piping loops.

F. The boiler shall have no minimum return water temperature requirements.

G. The boiler shall have no minimum flow rate requirements.

2.4 CONTROLS

A. The flame safeguard system shall be Fulton Model RM7865 with LED display module. The control shall provide a 35-second pre-purge and post-purge. The control shall maintain a running history of operating hours, number of cycles, and the most recent six faults. The control shall have the capability to be connected to a keyboard display module that will retrieve this information.

B. Pulse Combustion controls shall include the following:

1. Operating Temperature Controller for automatic start/stop of the pulse combustion process. Controller will have auto-tune PID capabilities for simplified loop configuration and fast response to water temperature fluctuations. A Type J temperature sensor shall be located in the boiler pressure vessel.
2. High limit temperature aquastat with manual reset.
3. One low water cutoff probe in the boiler shell with manual reset and push-to-test capability.
4. Air safety switch to prevent operation unless sufficient pre-purge air is assured.

5. High condensate cut-off probe located in the exhaust decoupler.
6. A Proof of Flame switch and Flame Rod operating in parallel, to prove combustion.

C. A combustion control system shall be furnished which provides a turndown ratio of 5:1 per ANSI Z21.13 (3:1 for LPG Fired Boilers) over the input range from high to low fire. The supply temperature and setpoint temperature shall be displayed at all times by the operating temperature control. Firing rate shall be controlled by a continuous 4-20mA analog signal to a modulation motor.

D. All controls to be panel mounted and so located on the boiler as to provide ease of servicing the boiler without disturbing the controls and also located to prevent possible damage by water according to CSA requirements. Electrical power supply shall be 120 volts, 60 cycle, single phase, 10 Amps maximum. Boiler shall draw less than 1 Amp while in run mode. No additional electric power shall be required for devices such as forced draft fans.

E. When multiple boilers are to be installed in a common hydronic loop, a Fulton ModSync Boiler Sequencing System shall be utilized. Please consult the ModSync specification for complete details on the capabilities and functions of this control.

2.5 MAIN GAS TRAIN COMPONENTS

A. The boiler shall have an integral gas train, factory assembled and installed. The main gas train will include:

1. One manual shut-off valve at gas inlet.
2. Gas inlet trap.
3. Gas regulator rated for a maximum14"wc supply pressure.
4. Two safety shut-off valves. One to be solenoid and one motorized valve.
5. Independent low and high gas pressure switches shall be supplied.

2.6 BOILER FITTINGS

A. Boiler shall be supplied with a ASME Section IV approved, side outlet type safety valve. The safety relief valve size shall be in accordance with ASME code requirements.

B. Temperature and pressure gauges shall be mounted on top of the boiler.

C. A condensate drain connection shall be provided in the exhaust decoupler. A Fulton condensate drain kit will be provided to collect and drain the flue gas condensate.

2.7 INSTALLATION

A. The boiler shall be CSA approved as a direct vent boiler. A conventional chimney or stack shall not be required. Direct venting shall be accomplished with AL-29-4C stainless steel, single (or double) wall. Vent piping shall be installed in accordance with applicable national and local codes and per the boiler manufacturers' recommendations.

B. The boiler shall have the outside combustion air intake supply ducted with PVC pipe and insulated ducting.

2.8 EMISSIONS

A. The boiler shall operate with CO emissions less than 100 PPM corrected to 3% O_2 and shall with NOx emissions less than 50 PPM corrected to 3% O_2 over the entire turndown range.

2.9 OPERATING MANUAL

A. Instructions for installation, operation and maintenance of the boiler shall be contained in a manual provided with each boiler unit.

B. A wiring diagram corresponding to the boiler configuration shall be permanently affixed to the boiler near the electrical panel.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Equipment and materials shall be installed in an approved manner and in accordance with the boiler manufacturers' installation requirements.

B. The installer shall construct a level continuous concrete pad (min. 3-1/2 inches high) for the entire boiler system according to the boiler manufacturer's erecting instructions.

C. Assemble unit sections and parts shipped loose or unassembled for shipment purposes. Follow manufacturer's installation recommendations and instructions.

D. Install electrical control items furnished by manufacturer per wiring diagram provided by manufacturer.

E. Complete water piping installation as required by manufacturer for operation of system.

F. Provide air intake and exhaust piping, size and type as recommended by the manufacturer.

G. Provide boiler manufacturer recommended manifold pipe and fittings from each boiler to nearest floor drain or as indicated.

3.2 FIELD QUALITY CONTROL

A. After boiler installation is completed, the manufacturer shall provide the services of a field representative for starting the unit and training the operator.

B. Arrange with National Board of Boiler and Pressure Vessel Inspectors for inspection of boilers and piping. Obtain certification for completed boiler units, deliver to Owner, and obtain receipt.

3.3 STACK

A. Stack shall be provided with all necessary accessories including fittings, hanging and wall support brackets, roof penetration thimble, exit cone or top ring, drain tee, storm collar and joint sealers as recommended by the manufacturer. Paint all exposed portions of the stack with rust inhibiting paint.

3.4 BOILER CLEANING

A. Prior to putting heating system into operation boil out boiler thoroughly with a sodium based product especially formulated for this purpose for a period of not less than 4 hours. Use at a rate recommended by the chemical manufacturer. Drain the solution at completion of boil-out and rinse twice.

3.5 TEST

A. Refer to Section 15060 for general test requirements and test boiler to 60 psig hydrostatic. Test tanks and other equipment to 1.5 times their operating pressures.

3.6 CHEMICAL TREATMENT

A. Test water and provide proper chemicals sufficient for system initial fill after acceptance of project. Furnish to Owner list of chemicals recommended, anticipated usage, present costs and name of local distributors where chemicals are available.

3.7 EQUIPMENT START-UP

A. Employ a full-time, factory trained service technician to provide start-up, balancing and owner operating and maintenance instruction for a period not to exceed two (2) consecutive days. In addition, provide one (1) year manufacturer's warranty service from date of start-up for beneficial use. A start-up report is to be provided to no more than 2 weeks after start-up.

END OF SECTION

PART 1 - GENERAL

1.1 SYSTEM DESCRIPTION

A. Microprocessor controlled, air-cooled liquid chiller utilizing scroll compressors, low sound fans.

1.2 QUALITY ASSURANCE

A. Unit shall be rated in accordance with ARI Standard 550/590-2003 (U.S.A.).

B. Unit construction shall comply with ASHRAE 15 Safety Code, UL 1995, and ASME applicable codes (U.S.A. codes).

C. Unit shall be manufactured in a facility registered to ISO 9001:2000 Manufacturing Quality Standard.

D. Unit shall be full load run tested at the factory.

1.3 DELIVERY, STORAGE AND HANDLING

A. Unit controls shall be capable of withstanding 150 F (66 C) storage temperatures in the control compartment.

B. Unit shall be stored and handled per unit manufacturer's recommendations.

PART 2 - PRODUCTS

2.1 EQUIPMENT

A. General: Factory assembled, single-piece chassis, air-cooled liquid chiller. Contained within the unit cabinet shall be all factory wiring, piping, controls, refrigerant charge, and special features required prior to field start-up.

B. Unit Cabinet:

1. Frame shall be of heavy-gage galvanized steel.
2. Cabinet shall be galvanized steel casing with a baked enamel powder or pre-painted finish.
3. Cabinet shall be capable of withstanding 500-hour salt spray test in accordance with the ASTM (U.S.A.) B-117 standard.

C. Fans:

1. Condenser fans shall be direct-driven, 11-blade airfoil cross-section, reinforced polymer construction, shrouded-axial type, and shall be statically and dynamically balanced with inherent corrosion resistance.
2. Two-speed or single fan operation shall allow reduced sound levels during scheduled unoccupied operating periods. Manufacturers without unoccupied reduced sound capability shall submit 1/3 octave band data and sound power data as measured according to ARI 370 as confirmation of unit sound characteristics.
3. Air shall be discharged vertically upward.

4. Fans shall be protected by coated steel wire safety guards.

D. Compressors:

1. Fully hermetic scroll type compressors.
2. Direct drive, 3500 rpm, protected by line break device, suction gas cooled motor.
3. External vibration isolation - rubber in shear.

E. Cooler:

1. Cooler shall be rated for a refrigerant working side pressure of 450 psig (3103 kPa) and shall be tested for a maximum fluid-side pressure of 150 psig (1034 kPa).
2. Shall be single-pass, ANSI type 316 stainless steel, brazed plate construction.
3. Shell shall be insulated with 3/4-in. (19 mm) closed-cell, polyvinyl-chloride foam with a maximum K factor of 0.28.
4. Shall incorporate 2 independent refrigerant circuits on sizes 035 to 055; sizes 010 to 030 shall have one independent refrigerant circuit.
5. Cooler shall have an optional factory-installed heater, to protect cooler from ambient temperature freeze down to –20 F (–29 C).

F. Condenser:

1. Coil shall be air-cooled with integral subcooler, and shall be constructed of aluminum fins mechanically bonded to seamless copper tubes.
2. Tubes shall be cleaned, dehydrated, and sealed.
3. Assembled condenser coils shall be leak tested and pressure tested at 450 psig (3103 kPa).

G. Refrigeration Components: Refrigerant circuit components shall include filter drier, moisture indicating sight glass, thermal expansion device, and complete operating charge of both refrigerant and compressor oil.

H. Controls, Safeties, and Diagnostics:

1. Controls:
   a. Unit controls shall include the following minimum components:
   b. Microprocessor with non-volatile memory. Battery backup system shall not be accepted.
   c. Single terminal block for power and controls.
   d. Control transformer to serve all controllers, relays, and control components.
   e. ON/OFF control switch.
   f. Replaceable solid-state relay panels and controllers.
   g. Pressure sensors installed to measure cooler entering and leaving saturated temperatures and outside air temperature. Thermistors installed to measure cooler entering and leaving fluid temperatures. Provision for field installation of accessory sensor to measure compressor return gas temperature.
2. Unit controls shall include the following functions:
   a. Automatic circuit lead/lag for dual circuit chillers.
   b. Capacity control based on leaving chilled fluid temperature and compensated by rate of change of return-fluid temperature with temperature set point accuracy to 0.1° F (0.06° C).
   c. Limiting the chilled fluid temperature pulldown rate at start-up to an adjustable range of 0.2° F to 2° F (0.11° C to 1.1° C) per minute to prevent excessive demand spikes at start-up.
   d. Seven-day time schedule.
   e. Leaving chilled fluid temperature reset from return fluid.

f. Chilled water pump start/stop control and primary/standby sequencing to ensure equal pump run time.
g. Dual chiller control for parallel chiller applications without addition of hardware modules, control panels, thermometer wells.
h. Unoccupied low sound operation to limit condenser fan sound during scheduled periods.
i. Timed maintenance scheduling to signal maintenance activities for pumps, condenser coil cleaning, strainer maintenance and userdefined maintenance activities.
j. Boiler enable signal to initiate system heating mode.
k. Low ambient protection to energize cooler and hydronic system heaters.
l. Periodic pump start to ensure pump seals are properly maintained during off-season periods.

3. Diagnostics:
   a. The control panel shall include, as standard, a scrolling marquee display capable of indicating the safety lockout condition by displaying a code for which an explanation may be scrolled at the display.
   b. Information included for display shall be:
      1) Compressor lockout.
      2) Loss of charge.
      3) Low fluid flow.
      4) Cooler freeze protection.
      5) Thermistor malfunction.
      6) Entering and leaving-fluid temperature.
      7) Evaporator and condenser pressure.
      8) Time of day:
         a) Display module, in conjunction with the microprocessor, must also be capable of displaying the output (results) of a service test. Service test shall verify operation of every switch, thermistor, fan, and compressor before chiller is started.
         b) Diagnostics shall include the ability to review a list of the 20 most recent alarms with clear language descriptions of the alarm event. Display of alarm codes without the ability for clear language descriptions shall be prohibited.
         c) An alarm history buffer shall allow the user to store no less than 20 alarm events with clear language descriptions, time and date stamp event entry.
         d) The chiller controller shall include multiple connection ports for communicating with the local equipment network, the Carrier Comfort Network® (CCN) system and the ability to access all chiller control functions from any point on the chiller.
         e) The control system shall allow software upgrade without the need for new hardware modules.

4. Safeties:
   a. Unit shall be equipped with thermistors and all necessary components in conjunction with the control system to provide the unit with the following protections:
      1) Loss of refrigerant charge.
      2) Reverse rotation.
      3) Low chilled fluid temperature.
      4) Thermal overload.
      5) High pressure.
      6) Electrical overload.
      7) Loss of phase.
   b. Condenser fan and factory pump motors shall have external overcurrent protection.

I. Operating Characteristics:

1. Unit shall be capable of starting and running at outdoor ambient temperatures from 45 F (7 C) to 120 F (50 C) for sizes 010-018 or 32 F to 120 F (0° to 52 C) for sizes 022-055.
2. Unit shall be capable of starting up with 95 F (35 C) entering fluid temperature to the cooler.

J. Motors: Condenser fan motors shall be totally enclosed single or dual speed, 3-phase type with permanently lubricated bearings and Class F insulation (except Motormaster® V control motors which shall be open type and shall have Class B insulation).

K. Electrical Requirements:

1. Unit primary electrical power supply shall enter the unit at a single location.
2. Primary electrical power supply shall be rated to withstand 120 F (50 C) operating ambient.
3. Unit shall operate on 3-phase power at the voltage shown in the equipment schedule.
4. Control points shall be accessed through terminal block.
5. Unit shall be shipped with factory control and power wiring installed.
6. Accessory storage tank cooler heater requires a separate power source.

L. Chilled Water Circuit:

1. Chilled water circuit shall be rated for 300 psig (2068 kPa). Units with optional pump package are rated for 150 psig (1034 kPa) working pressure.
2. Solid state flow monitor with integral relay shall be factory installed and wired.

M. Special Features:

1. Minimum Load Control: Unit shall be equipped with factory (or field) installed, microprocessor-controlled, minimum load control that shall permit unit operation down to a minimum of 15% capacity (varies with unit size).
2. Energy Management Module: A factory or field-installed module shall provide the following energy management capabilities: 4 to 20 mA signals for leaving fluid temperature reset, cooling set point or demand limit control; 2-point demand limit control (from 15% to 100%) activated by a remote contact closure; and discrete input for “Ice Done” indication for ice storage system interface.
3. Security Grilles: Unit shall be supplied with factory (or field) installed painted grilles to protect the condenser, cooler, and compressor from physical damage.
4. BACnet™ Translator Control: Unit shall be supplied with field-installed interface between the chiller and a BACnet Local Area Network (LAN, i.e., MS/TP EIA-485).
5. GFI Convenience Outlet: Shall be factory or field-installed or mounted with easily accessible 115-v female receptacle. Shall include 4 amp GFI receptacle.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Decommission existing unit, remove using proper rigging and lifting equipment

B. Install in accordance with manufacturer's instructions.

C. Align chiller package on steel or concrete foundations.

D. Connect to electrical service.

E. Connect to chilled water piping.

F. Arrange piping for easy dismantling to permit tube cleaning.

3.2 MANUFACTURER'S FIELD SERVICES

A. Supply service of factory trained and authorized representative for a period of two full days to checkout, start-up, verify proper operation and provide 2 hours of owner training on operation and maintenance of the unit.

B. Supply initial charge of refrigerant and oil.

C. Supply service of factory trained representative for tie-in, startup and checkout of existing building controls to the new chiller controls.

3.3 MANUFACTURERS

A. Carrier, Trane, York, McQuay.

END OF SECTION

PART 1 – GENERAL

1.1 DESCRIPTION

A. Provide Air Handling and Heating Equipment as specified herein and shown on the Drawings.

B. Equipment capacity and size as indicated in the equipment lists on the Drawings.

1.2 QUALITY ASSURANCE

A. Air Handling Equipment: Rated in accordance with AMCA certified rating procedures and AMCA labeled.

B. Air Conditioning and Refrigeration Equipment Rating: Rated in accordance with ARI certified rating procedures and AMCA labeled.

C. Codes: Comply with applicable sections of the State Mechanical Specialty Code.

D. Field Wiring: Comply with requirements of Section 15050.

PART 2 - PRODUCTS

2.1 AIR HANDLING EQUIPMENT

A. Air Handling Units:

1. Fan Section: Size, type and capacity indicated.
   a. Heavy duty centrifugal dynamically balanced fan wheel tested and rated in accordance with AMCA and with ratings corrected for effect of cabinet enclosure. Blade type as shown on Plans. All bearings pressure lubricated ball or roller type with safety pressure relief grease fitting; locate all grease fittings in accessible position on casing and connect to bearings with copper tube lines.
   b. Mount motor and drive inside the unit casing on open spring vibration isolation where indicated on the Drawings.
   c. Provide exhaust/recirculation fan section where indicated on the Drawings matching the supply fan section construction.
2. Variable Volume Control Equipment: Provide the following:
   a. Variable frequency drives as subsequently specified.
   b. Equip the exhaust-recirculation fan with the same capacity controller as the supply fan section.
3. Unit Casing: Factory fabricated and tested 2” thick double wall casing construction of 2" thick, 1-1/2 lb. density fiberglass secured between minimum 18 gauge outer and 22 gauge inner galvanized steel, with factory enamel or galvanized outside finish coat. Provide access panels in casing for servicing all internal portions and provide continuous steel support base under all sections indicated.
4. Outside, Return and Exhaust Damper Section: Construct of minimum 16 gauge black enameled steel or aluminum, with maximum 48" blade lengths and blades reinforced with continuous full length axle shafts and/or operating "jackshafts" as required to provide coordinate tracking of all blades. Interlocking, multi-blade type, except where either dimension is less than 10" a single blade may be used. Opposed blade type on all modulating dampers and parallel blades on all two position dampers. Damper assembly

rated for maximum air leakage of 2% at 2" wg pressure and with interconnecting blade linkages in the side channels of the frame. Johnson D-1300 or D-1200, Ruskin CD45, Arrow Pin-Lock, or approved.

5. Heating Coils: Non-ferrous extended surface, counterflow serpentine type with heavy gauge galvanized steel casing suitable for mounting required. Assembled with 5/8” OD x 0.020” thick copper tubes brazed to copper or steel headers with drain and vent tappings. Copper or aluminum fins mechanically bonded to tubes and spaced a maximum of 12 fins per inch. Construction shall allow for expansion and contraction without developing leaks. Permanently label each coil in accessible location with all operating parameters. Trane, Carrier, Heatcraft, Colmac, or by approved air handling unit manufacturer. As subsequently specified.
6. Filters: As subsequently specified.
7. Acceptable Manufacturers: Carrier, Trane, York, McQuay.

B. Class 1 Centrifugal Fan: Constructed and rated in accordance with AMCA Class 1 air-foil, forward curved or backward inclined blade. See Drawings for arrangement, outlet velocity, tip speed and capacity. Mount motor on adjustable slide rails, ball or roller, pressure lubricated bearings for both fan and motor; equip with pressure relief type grease fittings and belt guard. Peerless, Acme, Trane, Carrier, American Air Filter, Barry or approved.

2.2 EXHAUST FANS AND UNITS

A. Exhaust-Return Unit:

1. Size, type and capacity indicated. Factory fabricated and tested casing construction of formed angle box frame with reinforced 16 gauge skin, lined with minimum 1" thick duct liner applied with mechanical fasteners, 12" on center and with factory enamel or galvanized outside finish coat. Provide lined access panels in casing for servicing. Heavy duty centrifugal dynamically balanced fan wheel tested and rated in accordance with AMCA and with ratings corrected for effect of cabinet enclosure. Blade type as indicated on Plans. All relief grease fittings; locate all grease fittings in accessible position on casing and connect to bearings with copper tube lines. Trane, Carrier, American Air Filter, McQuay, Bohn, Dunham-Bush or approved.
2. Motor and drive shall be mounted inside the unit casing on open spring vibration isolation as indicated on the Drawings. Carrier, Trane, McQuay, or approved.
3. Variable volume systems shall have inlet vane, scroll, variable speed drive assembly or discharge dampers as required to maintain static pressures.

B. Inline Cabinet Exhaust Fan: Belt drive, forward curved centrifugal wheel, sleeve bearings, motor and wheel and external spring vibration isolators; provide duct connection with backdraft dampers on discharge. Size and capacity as indicated on Drawings. Provide neoprene flexible connections on intake and discharge. Carnes VDBA, Penn Zypher, Greenheck BCF, Breidert, Jen Fan, Cook DB or approved. Where noted, motor shall be external of fan cabinet.

C. Roof Mounted Exhaust Fan (Belt Drive): Curb mounted on roof; vertical shaft, belt driven, open BI wheel as shown on Drawings with pressure lubricated ball bearings; ball bearing fan duty motor; vibration isolated; bird screen; weatherproof aluminum housing for mounting on square base; capacity as indicated on Drawings. Motor located outside the air stream. Casing to be easily removed for service. Motor and fan assembly to be mounted on rubber vibration isolators. Where indicated on the Drawings, provide backdraft damper in curb. Provide switch with pilot light for each fan so indicated. Provide factory mounted disconnect. Greenheck GB, Breidert DB, Jen Fan DB, Carnes VEBK, Acme PV, Penn DOMEX, Cook ACE-B or approved.

D. Grease Hood Exhaust Fan: Curb mounted on roof; vertical shaft, belt driven, enclosed BI wheel as shown on Drawings with pressure lubricated ball bearings; ball bearing fan duty motor isolated

from exhaust air stream. Low silhouette vertical discharge housing for mounting on square base. Capacity as indicated on Drawings. Provide switch with pilot light for each fan so indicated. Provide cleanout access and ventilating curb mounting base. Acme Centri-Master, Penn Fumex, Acme PNU-RG, Carnes VUBA, Greenheck CUBE, ," Bredidert TXB, Jen Fan TXB, Cook VCR or approved.

E. Utility Set Exhaust Fan: AMCA rated and construction of wheel inclination, arrangement, rotation discharge, outlet velocity, tip speed and capacity as scheduled on the Drawings. Mount motor on adjustable base; pressure gun lubricated ball or roller bearings for both fan and motor. Provide with weather proof housing where located outside. Trane, Utility, Cook, Barry, Carrier, Greenheck, Peerless, Acme or approved.

2.3 INDOOR INDIRECT GAS FIRED KITCHEN HEATING AND MAKE-UP UNIT

A. General: AGA and serving utility approved indirect fired, heating and ventilating unit. Centrifugal FC belt driven fans and motors internally isolated in insulated metal casing.

B. Burner: Indirect-fired 321 stainless steel heat exchanger/burner with spark ignited intermittent pilot for natural gas. Provide solid state electronic modulation down to 30% of rated input capacity with remote selector switch to adjust leaving air temperature. Unit shall separate combustion duct.

C. Minimum gas and electric controls shall include combustion gas valve containing main and pilot gas cocks, main and pilot gas pressure regulators, redundant solenoid gas valves, pilot solenoid gas valve, 100% safety shut-off, high limit control, control transformer, control box with dead front fused disconnect switch or circuit breaker, and remote control station with switches and indicating lights. Unit shall have electronic modulation with remote room thermostat.

D. Accessories: Unit casing including hinged and latched service enclosure, insulated blower section, automatic 100% outside air intake dampers, filter section with 4" pleated filters, vibration isolators, extended grease lines to accessible side of unit, variable pitch sheave for motors, low outlet temperature shut-off, remote room thermostat, steel support base, power venter and adapter.

E. Unit shall function as heating unit vent (with economizer) until kitchen hood is switched on and unit shall go to 100% outside air.

F. Acceptable Manufacturers: Hastings, Reznor, Modine, Sterling, Greenheck, or approved substitute.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install and arrange equipment as shown on the Drawings and as recommended by the equipment manufacturer.

3.2 ROOF MOUNTED EQUIPMENT INSTALLATION

A. All roof mounted mechanical equipment shall be supported and seismically anchored on levelled, flashed and counterflashed vibration isolated curbs anchored to resist seismic forces and suitable for the roof construction. Minimum curb height shall be 12" above the roof unless indicated otherwise on the Drawings. Flashing into the roof is specified in another Section.

B. Make all piping, electrical and duct penetrations for each equipment within the curb unless shown otherwise on the Drawings. Piping and electrical conduit routed above and across the roof shall be supported on flashed and counterflashed curbs with pipe guides anchored to the curbs in "pitch pockets." Submit shop drawings on other arrangements for approval.

C. Acoustical Protection: Install two layers of 5/8" weatherproof sheet rock with staggered joints on the perimeter angle and cross members provided with the vibration isolator bases. Apply sheet rock around all ductwork above the roof and caulk all joints and seams. Provide additional acoustical materials as recommended by acoustical engineer.

3.3 AIR HANDLING INSTALLATION

A. Installation and Arrangement: Air handling equipment shall be installed and arranged as shown on the Drawings. Comply with the manufacturer's recommendations for installation connection and start-up.

B. Lubrication: All moving and rotating parts shall be lubricated in accordance with the manufacturer's recommendations prior to start-up.

C. Filters: Specified filters or approved temporary construction filters shall be installed in supply units prior to start-up or used for drying and/or temporary heat.

3.4 SMOKE DETECTOR INSTALLATION

A. Provide duct-mounted smoke detectors at air handling units in accordance with Code requirements.

B. Where detectors are mounted in a concealed location, provide remote indicating panel located as directed.

END OF SECTION

PART 1 - GENERAL

1.1 DESCRIPTION

A. Provide Air Distribution Equipment as specified herein and as shown on the Drawings.

B. Equipment capacity and size shall be as indicated on the Drawings.

1.2 QUALITY ASSURANCE

A. Air Handling Equipment Rating: In accordance with AMCA certified rating procedures and bearing the AMCA label.

B. Ductwork: Comply with requirements of Chapter 6 and 5 for grease ducts of the Oregon State Mechanical Specialty Code.

C. Field Wiring: Comply with requirements of Section 15050**,** Article 1.2, paragraph D, Field Wiring.

PART 2 - PRODUCTS

2.1 SHEET METAL

A. Quality Assurance: Galvanized steel sheet metal except where otherwise indicated. Metal gauges, joints and reinforcement in accordance with Mechanical Code, ASHRAE and SMACNA tables and recommendations.

B. Acoustical Duct Lining: Line ducts with 1" thick lining for installation inside the building insulation envelope, and 1-1/2” 2” in eastern Oregon for installation outside the building insulation envelope. Schuller "Linacoustic," Gustin Bacon "Ultra-Liner," or Owens Corning "Aeroflex" approved, meeting NFPA 90A requirements for maximum flame spread and smoke developed. Mechanically attach lining to sheet metal duct with Schuller Grip Nails or Gramweld welding pins. Apply fire-retardant type adhesive similar to Schuller No. 44 adhesive, Benjamin Foster 81-99, Insul-Coustic 22 or 3M equivalent on all leading edges, joints and seams.

C. Duct Sealing Tapes: Provide one of the following UL listed ductwork sealing tape systems.

1. Two-part sealing system with woven fiber, mineral gypsum impregnated tape and non-flammable adhesive. Hardcast "DT" tape and "FTA-20" adhesive, United "Uni-Cast" system, or accepted substitute.
2. For joints and seams exposed to the weather in lieu of soldering, United "Uni-Cast" system or approved.

D. Duct Joints for Sheet Metal Ducts: "Ductmate System" by Ductmate Industries, Inc., for making transverse rectangular and round duct joints at contractor's option. Ward Duct Connectors, Inc., Lockformer TDC, Mez Industries, or acceptable substitute.

D. Exposed to View Round Supply Air Ductwork: Round and flat oval spiral seam galvanized sheet metal outer shell duct with 1" thick fiberglass insulation sandwiched between it and a perforated galvanized sheet metal inner liner. Provide factory manufactured fittings matching

ductwork. United Sheet Metal, Rolock, Semco Air System, Robert Lloyd Sheet Metal, Arrow, Dees, Arjae Sheet Metal.

E. Exposed to View Spiral Seam Duct: Round and flat oval spiral seam duct shall be manufactured of galvanized steel sheet metal with spiral lock seam. Sizes up to 36" diameter or 36" wide shall be 22 gauge; sizes over 36" shall be 20 gauge. Reinforcement or bracing shall be as detailed on the Drawings. Matching fittings shall be manufactured of galvanized steel with continuous welded seams. Fittings up to 36" diameter or width shall be 20 gauge, fittings larger than 36" shall be 18 gauge.

F. Concealed Spiral Seam Duct: Round and flat oval spiral seam duct shall be manufactured of galvanized sheet metal with spiral lock seam. Construction, gauges, and reinforcement in accordance with SMACNA standards. Fittings shall be manufactured of galvanized steel with spot welded or riveted and sealed seams or continuously welded seams.

G. Flexible Ductwork-Low Pressure: Insulated low pressure flexible duct, factory fabricated assembly consisting of a zinc-coated spring steel helix, corrugated aluminum seamless inner liner, wrapped with a nominal 1" thick insulation for installation inside the building insulation envelope, and 1-1/2” (2” in eastern Oregon) for installation outside the building insulation envelope, 1 pound/cubic foot density fiberglass insulation. The assembly shall be sheathed in a vapor barrier jacket, factory vapor resistance sealed at both ends of each section. The composite assembly, including insulation and vapor barrier, shall meet the Class 1 requirements of NFPA Bulletin No. 90-A and be labeled by Underwriters Laboratories, Inc., with a flame spread rating of 25 or less and a smoke developed rating of 50 or under. The duct shall have factory sealed double air seal (interior and exterior) to assure an airtight installation. Genflex, ATCO, Wiremold, Thermaflex, Glassflex, Clevepak, Schuller, or accepted substitute.

2.2 ACCESSORIES

A. Manual Volume Dampers: Construct of material two gauges heavier than duct in which installed; single plate up to 12" wide; multiple over 12" wide. Hem both edges 1/2" and flange sides 1/2". Use Young, Duro-Dyne or accepted substitute damper accessories. Young numbers are shown.

1. No. 605 bearing set with No. 403 regulator for dampers up to 24" long.
2. For dampers over 24" long use No. 660 3/8" rod, No. 656 end bearing and No. 403 regulator.
3. Where damper regulators are not readily accessible, use No. 660 or No. 661 rod extensions and No. 301 and No. 315 concealed damper regulators as required.

Location of all volume dampers is not necessarily shown on Drawings; minimum required is one in each supply, return or exhaust main and one in each branch.

B. Fire Dampers:

1. Static Fire Dampers: Constructed and installed in accordance with NFPA No. 90A and UL labeled.
2. Dynamic Fire Dampers: Constructed and approved in accordance with UL Standard 555 for horizontal or vertical installations. Selection of dampers shall not exceed manufacturer's recommended CFM at 4" of static pressure for unducted dampers and 8" of static pressure for ducted dampers.

C. Fire Rated Thermal Blanket and Diffuser Fire Damper: UL listed, non-asbestos ceramic thermal blanket for use on ceiling diffusers with curtain type fire damper to fit diffuser neck indicated.

D. Smoke Dampers:

1. Constructed and installed in accordance with NFPA No. 90A, UL labeled. Provide dampers with rating equal to surrounding construction where penetrations are made through fire-resistant rated construction per applicable codes.
2. Provide access panels of proper fire rating. Size dampers to maintain free area through damper same as unobstructed run of duct or opening.
3. Each damper shall have a minimum leakage rating of Class II under UL555S for use in smoke control systems.
4. In addition to the leakage rating specified herein, the dampers and their actuators shall be classified under UL555S to an elevated temperature of 250 degrees F (121 degrees C). Appropriate electric motorized operators shall be installed by the damper manufacturer at time of fabrication and damper/actuator assembly shall be factory cycled 10 times to assure operation. Assembly shall meet all applicable UL555S criteria for both damper and actuators. Damper shall be power open-fail close design.
5. Damper manufacturer shall provide factory assembled minimum 20 gage steel sleeve. Damper shall be sealed to the sleeve with a 25/50 flame spread/smoke developed sealant material.
6. Provide necessary relay to drop power to smoke damper motor when smoke detector at associated unit detects smoke and when unit is not running.
7. Provide all necessary wiring and devices to close dampers on a signal from the building fire alarm system.

E. Combination Fire/Smoke Dampers: Belimo motors only.

1. Constructed and installed in accordance with NFPA No. 90A, UL labeled. Provide dampers with rating equal to surrounding construction where penetrations are made through fire-resistant rated construction per applicable codes.
2. Provide access panels of proper fire rating. Size dampers to maintain free area through damper same as unobstructed run of duct or opening.
3. Each damper shall be classified by UL as a “corridor damper” for installation in tunnel corridors, shall be rated for one hour fire resistance under UL555, and shall have a minimum leakage rating of Class II under UL555S for use in smoke control systems. Each damper shall bear a UL label designating the damper as “corridor damper.”
4. In addition to the leakage rating specified herein, the dampers and their actuators shall be classified under UL555S to an elevated temperature of 250 degrees F (121 degrees C). Appropriate electric motorized operators shall be installed by the damper manufacturer at time of fabrication and damper/actuator assembly shall be factory cycled 10 times to assure operation. Assembly shall meet all applicable UL555 and UL555S criteria for both damper and actuators. Damper shall be power open-fail close design.
5. Damper manufacturer shall provide factory assembled minimum 20 gage steel sleeve. Damper shall be sealed to the sleeve with a 25/50 flame spread/smoke developed sealant material. Each corridor damper shall be equipped as standard with an electric fusible link. These fusible links shall be rated for 165 deg. F (74 deg. C) and shall be easily resettable for system testing.
6. Provide necessary relay to drop power to smoke damper motor when smoke detector at associated unit detects smoke and when unit is not running.
7. Provide all necessary wiring and devices to close dampers on a signal from the building fire alarm system.
8. Provide area smoke detectors in the corridor arranged to activate the dampers.

F. Exterior Wall Louvers: Prefabricated galvanized sheet metal fixed stormproof blades with frame to suit building construction, and with 1/2" x 1/2”, 16 gauge galvanized wire mesh on back side of all intake louvers and insect screen on exhaust/relief louvers. 4” deep, 45 degree fixed drainable type blade, AMCA 500 tested for 800 fpm without water penetration, and maximum of 0.07” wg intake pressure loss and 0.09” wg exhaust pressure loss. Provide “Kynar” protective

coating and stainless steel fasteners (ASTM A167, type 302, cadmium finish, ASTM A165 type NS). Ruskin L375D, Cesco SLS4-DB-38, American Warming LF-21, Greenheck or approved.

G. Gravity Exhaust Head Outside Air Intake:

1. Rectangular glass fiber or aluminum cap to match exhaust fan housing with backdraft dampers, curb connection, flashing, 1/2" mesh galvanized bird screen and hinged access. Greenheck, Exitaire, Carnes, Acme, Powerline, Penn or accepted substitute.
2. Install with automatic relief damper in curb as indicated on the Drawings.

H. Locking Connection Straps: 1/2" wide positive locking steel straps or nylon self-locking straps. Panduit or accepted substitute.

I. Connection Fittings: Connections to non-metallic ducts manufactured sheet metal "spin-in" fittings. Genflex, Wiremold, Thermaflex, Glassflex, Clevepak, Schuller, or accepted substitute.

J. Access Doors In Sheet Metal Work:

1. Hollow core double construction of same or heavier gauge material as duct in which installed. Use no door smaller than 12" by 12" for simple manual access or smaller than 18" by 24" where personnel must pass through infrequently. Use 24" by 60" minimum for filters and more frequent maintenance. Use Ventlok or accepted substitute hinges and latches on all doors.
   a. 100 series hinges and latches on low pressure system doors up to 18" maximum dimension.
   b. 200 series on larger low pressure system doors and 333 series on high pressure systems.
2. Construct doors up to 18" maximum dimension with 1" overlap, furr and gasket with 3/4" by 1/8" sponge rubber. Fit larger doors against 1-1/2" by 1/8" or angle frame and gasket with 3/4" by 1/8" sponge rubber or felt.

K. Visual Access Panels: Install visual access panels in inlet side of all coils, at all motorized dampers, and at all fire dampers where otherwise indicated on Drawings. Construct of 18 gauge steel, 20 gauge cold rolled cover, latex gasket and 1/4" plate glass. Minimum 12" by 12" unless indicated otherwise. Coordinate with manufacturer of air handling equipment, in mixing plenums, at coils, etc. Young Regulator Company No. 1311, Pace No. 12 or accepted substitute.

L. Opposed Blade Volume Damper: Install opposed blade volume damper in each zone supply duct on discharge of multi-zone units and where indicated on Drawings. Young No. 817 or accepted substitute.

M. Flexible Connections: Neoprene impregnated fiberglass connection. Ventglass, Duro-Dyne, or accepted substitute.

2.3 GRILLES, REGISTERS AND DIFFUSERS

A. Description: Provide grilles, registers and diffusers as shown on the Drawings.

B. Finishes:

1. Steel: Flat white enamel prime coat, factory applied on ceiling diffusers. Others are to have a baked enamel finish, color as selected by Architect.
2. Aluminum: Anodized clear finish unless indicated otherwise.

C. Manufacturers: Carnes, Krueger, Titus, Price are accepted substitutes where only Titus model numbers are listed. Where other manufacturer's products are listed and/or "accepted substitute" is indicated, only the products or an accepted substitute for that item shall be provided.

D. Modular Core Direction Diffusers: Rectangular type with pattern of distribution as indicated. Price SMCD.

E. Ceiling Matched Return and/or Exhaust Register: To match adjacent ceiling outlets. Use in spaces containing ceiling diffusers and/or T-bar ceilings. Provide with damper except where dampered plenums are indicated. Match manufacturer of supply.

F. Sidewall Supply Grille or Register: Double deflection grille with face bars parallel to long dimension on ceiling type and horizontal on wall type; bars to be individually adjustable, spaced on 0.66" to 0.75" centers; key operated opposed blade volume damper. Titus 300RL.

G. Sidewall or Ceiling Return or Exhaust Register: Face bars parallel to long dimension on ceiling type and horizontal on wall type; bars set at 35 degrees to 45 degrees, spaced on 0.66" to 0.75" centers; key operated opposed blade volume damper. Titus 350RL series.

H. Sidewall or Ceiling Return, Exhaust or Relief Grille: Face bars parallel to long dimension on ceiling type and horizontal on wall type; bars set at 35 degrees to 45 degrees, spaced on 0.66" to 0.75" centers. Titus 350 series.

I. Linear Bar Grille: Price LBP. See drawings for core style.

J. Drum Type Outlet: Extruded aluminum adjustable "drum" type outlet with adjustable vertical blades and opposed blade volume damper behind. Select based upon duct size, throws, and sound levels indicated. Titus DL.

K. Steel Door Transfer Grilles and Sidewall Transfer grilles: All welded construction with 20 gauge, fixed inverted V-blades with a deflection angle of 77° so as to provide a sight proof design. Titus T-700L.

L. Gymnasium-Heavy Duty Return or Exhaust Grille: All welded construction with heavy 0.12" (11 gauge) by 1/2" rounded edge steel horizontal face bars set at 40 degrees to 45 degrees. Face bars to be at 1/2" on centers and reinforced every 6" to 8". Price 91 series.

M. Plaster Frames: Provide plaster frames for all diffusers, grilles or registers installed in plaster walls or ceiling. Where register face is aluminum, the plaster frame shall be aluminum. Frame to match manufacturer of register or be of compatible size of listed manufacturer. Titus TRM/TRM-S.

N. Reinforcement: Installing contractor to reinforce all return or exhaust grilles or registers with either dimension greater than 36" on rear of face both ways with 1" x 1" x 1/8" angle spaced 12" on center.

2.4 AIR TERMINALS

A. Variable Air Volume Terminal Box: Construct unit casings of 22 gauge galvanized steel fully lined with 1/2", 2 lb. density, neoprene coated fiberglass complying with the UL Standard 181 for erosion, and NFPA 90A for fire resistivity. Cover liner with Mylar film**.**

1. Unit Inlets: Round, obround, or rectangular.
2. Attenuation Section: Integral to the basic unit.
3. ADC Certified: Test in accordance with ADC test code 1062 R4.

4. Unit Sound Power Levels (second through seventh octave band): At minimum pressure drop, ratings shall not exceed 32 NC ducted or radiated.
5. Pressure Independent VAV Terminals: Equip with velocity controls to control cfm independent of duct static pressure.
6. Field installed equipment: All actuators, controls, and circuitry contained in a sheet metal enclosure. System shall be integral to the DDC system being provided for the facility.
7. Reheat Coil: Provide heating water reheat coils of capacities indicated.
8. Manufacturers: Trane, Titus, Tempmaster, Carrier, Price, Carnes, Krueger, Envirotech, or approved substitute.

2.5 AIR FILTERS

A. Filter Gauges: Dwyer 2000-AF series or accepted substitute, across each filter bank. Provide option "LT" on all gauges exposed to conditions below 35 degrees F. Mount gauge securely at a point free of vibration.

B. Disposable Media, 30% Efficient Filters:

1. Disposable, preformed media, pleated 2" thick cartridge type with minimum 16 gauge steel holding frames. Average ASHRAE test efficiency of 30% or greater with initial pressure drop across the clean filter bank not exceeding 0.3" wg when operating at full rated filter capacity. The filter media shall have an Underwriters Laboratories Class II listing.
2. Apply industrial tape to all joints between frames and joints to adjacent sheet metal and/or caulk as required to prevent leakage. Provide specified filters for temporary heat and testing during construction and replace filters with new clean, specified filters prior to acceptance of project by Owner (two complete sets of media are required). Provide 0 to 1" wg filter gauge.
3. Farr 30/30, Airguard DP2-40, Eco-Air C35 and American Air Filter Type AM-AIR 300X or approved substitute.

PART 3 - EXECUTION

3.1 EQUIPMENT INSTALLATION

A. Air Handling Equipment Installation and Arrangement: Install and arrange as shown on Drawings. Comply with the manufacturer's recommendations for installation, connection, and start-up.

B. Equipment Access Panels: Locate free of all obstructions such as ceiling bars, electrical conduit, lights, ductwork, etc.

C. Filters: Install specified filters or accepted substitute temporary construction filters in supply units and systems prior to start-up or use for drying and/or temporary heat. Replace prior to acceptance of project.

3.2 INSTALLATION OF GRILLES, REGISTERS AND DIFFUSERS

A. Size and air handling characteristics shall be as shown on the Drawings.

B. Locate, arrange, and install grilles, registers and diffusers as shown on the Drawings. Locate registers in tee-bar ceilings with diffusers centered on the tile unless indicated otherwise.

3.3 DUCTWORK INSTALLATION

A. Support: Install ductwork with 1" wide 16 gauge cradle hangers not more than 8' on centers or as required by code. Support terminal units independent of adjacent ductwork. Attach to available building construction according to good practices for materials involved.

B. Fan and Air Handling Unit Flexible Connections: Install neoprene impregnated fiberglass connections in ductwork at all rotating equipment. Ventglass, Duro-Dyne or accepted substitute.

C. Elbows and Fittings: Construct elbows with throat radius equal to duct width in plane of turn or make them square and provide double wall, air foil turning vanes.

D. Fittings: Make transitions and take-offs as shown on Drawings. Provide volume dampers and splitter dampers as indicated on Drawings and as specified. Saddle tees are not allowed.

E. Acoustical Duct Lining: Acoustically line all fan unit intake and discharge plenums, all ductwork indicated as lined on the Drawings, all sheet metal ductwork specified per Section 15250 as insulated, where exposed to view or subject to damage in areas such as mechanical rooms, and, at the Contractor's option, all insulated ductwork specified in Section 15250. The duct size noted on the Drawings is the clear opening of the duct with insulation. Insulation shall not reduce duct size listed. No high pressure/velocity duct systems, grease and moisture conveying duct systems or computer and health care supply duct systems shall be internally lined.

F. Manual Volume Dampers: Location of all volume dampers are not necessarily shown on the Drawings. Provide a minimum of one volume damper in each supply, return or exhaust branch. Install dampers in fiberglass ductwork (where fiberglass ductwork is allowed) with galvanized sheet metal sleeves of sheet metal gauges required for metal duct systems of the same dimensions.

G. Duct Insulation: Insulate all ductwork specified in Section 15250 as requiring insulation. In addition, all ductwork indicated in Table No. 53F of the Structural Specialty Code and Fire and Life Safety Regulations shall be insulated or lined.

H. Sleeves: Provide galvanized sheet metal plaster ring around ductwork penetrating exposed finished walls. Sleeve and flash all duct penetrations through exterior walls in an air tight and weatherproof manner. At all walls called out to be Sound Walls, and that extend to roof structure, provide sheet metal sleeve set in acoustic sealant on one side of the wall, fill the void from the other side with acoustic sealant.

I. Plenums: Construct sheet metal plenums and partitions of not lighter than 18 gauge galvanized steel and reinforce with 1-1/2" by 1/2" by 1/8" angles as required to prevent drumming or breathing.

J. Access: Install necessary access opening and covers for cleaning, wiring or servicing motors, filters, fans, both entering and leaving air sides of coils, fire and/or smoke dampers and to other equipment located within or blocked by sheet metal work.

K. Sealing: Caulk, seal, grout and/or tape ductwork and plenums to make airtight at seams, joints, edges, corners and at penetrations. Solder all seams, joints, etc., on all ductwork exposed to the weather. Install specified tape in accordance with manufacturer's requirements using degreaser on surfaces to be taped and wiped to eliminate moisture.

L. Flexible Duct Connections:

1. Install in full extended condition, free of sags and kinks, using only the minimum length required to make the connection.

2. Make all joints and connections with 1/2" wide positive locking steel straps or nylon self-locking straps and make connections to non-metallic ducts with sheet metal sleeves or manufactured sheet metal "spin-in" fittings.
3. Thoroughly coat all high pressure duct interior with an approved high pressure duct sealer to overlap 3" and secure in place over sheet metal collar with 1/2" wide positive locking strap. On vertically suspended ducts, secure with a minimum of three sheet metal screws on a maximum of 8" on center.

3.4 FIELD QUALITY CONTROL

A. Disassemble, reassemble, and seal segments of systems as required to accommodate leakage testing and as required for compliance with test requirements.

B. Conduct test, in presence of owner representative, at static pressures equal to maximum design pressure of system or section being tested. If pressure classifications are not indicated, test entire system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure. Give seven days' advance notice for testing.

C. Determine leakage from entire system or section of system by relating leakage to surface area of test section.

D. Maximum Allowable Leakage: Comply with requirements for Leakage Classification 3 for round and flat-oval ducts, Leakage Classification 12 for rectangular ducts in pressure classifications less than and equal to 2-inch wg (both positive and negative pressures).

E. Remake leaking joints and retest until leakage is less than maximum allowable.

F. Leakage Test: Perform tests according to SMACNA's "HVAC Air Duct Leakage Test Manual."

3.5 FIRE DAMPERS

A. Provide fire dampers with rating equal to surrounding construction where penetrations are made through fire resistant rated construction per applicable codes and installed in accordance with UL label requirements. Locate fusible links for easy service or replacement and provide access panels of proper fire rating. Size fire dampers to maintain free area through fire damper same as unobstructed run of duct. Where dampers are installed in forced air systems which may not shut down under fire conditions, dampers shall be UL "dynamic-rated" dampers.

B. The location of all fire dampers shall be identified on the record drawings.

3.6 FIRE/SMOKE DAMPERS

A. Same as fire dampers above except provide complete wiring including electrical connections between field connected components and the fire alarm system specified in Division 16.

B. The location of all smoke dampers shall be identified on record drawings. Disconnects for smoke dampers shall be no more than 12 inches above the ceiling grid. The panel source for the fire smoke damper in the electrical panels shall also be identified.

C. Belimo motors only.

3.7 NEW DUCTWORK CLEANING

A. Store all ductwork materials on pallets or above grade, protected from weather, dirt/mud and other construction dust.

B. Remove all accumulated dust, dirt, etc. from each duct section as it is being installed.

C. Prior to installation of diffusers, grilles and registers, install temporary system filters and cover all diffuser, grille and register openings with temporary 25% efficiency filter materials and start the fan systems. Operate fans a minimum of 8 hours. Remove all temporary filters at the end of that period.

D. Clean all diffusers, grilles and registers just prior to project final completion.

END OF SECTION

PART 1 - GENERAL SYSTEM DESCRIPTION

1.1 GENERAL REQUIREMENTS

A. Drawings and general provisions of the Contract, including General and other Conditions and other Division 1 – General Requirements sections, apply to the work specified in this Section.

1.2 BASIC SYSTEM

A. Building Automation System (BAS) system shall utilize DDC to control valve and damper actuators for all mechanical equipment as specified in the sequence of operation and in the drawings for all systems.

C. The system shall include all computer software and hardware, control unit hardware and software, operator input/output devices, sensors, control devices, and miscellaneous devices required for complete operation and future modifications. Documentation for all software and hardware devices shall be provided.

D. Provide engineering, installation, calibration, commissioning, acceptance testing assistance, software programming, and checkout for complete and fully operational DDC.

1.3 SPECIAL INSTRUCTIONS TO THE CONTRACTOR

A. Control system shall be Johnson Metasis control systems. Exemption from ORS 279C.342(2) has been provided.. No other system will be approved.

1.4 SCOPE OF SERVICES (OVERVIEW OF SECTION 15900)

A. Work under this section of the specification shall include, but not limited to, the following:
1. Furnish and install a complete sensor, actuator, wiring and piping system for all air handling and related equipment as shown on the plans and specified in this section. Install all necessary sensors and actuators as required by the plans and specifications and equipment schedules. Coordinate installation of factory mounted controls. Factory mounted devices except for valves and damper actuators to match manufacturer of control system.
2. Label all sensors, control devices, and control units.
3. Furnish and install conduit, wire, branch circuit protection, etc. as required to bring 120 VAC power to control panel locations and equipment (actuators, sensors, control devices, etc.) as shown on the drawings and described in the specifications.
4. All line drivers, signal boosters, and signal conditioners etc. shall be provided as necessary for proper data communication.
5. Coordination as required with other sections of the specification for the proper and complete installation of the wiring and tubing system, control devices, dampers, valve, actuators, etc.
6. Furnish and install Direct Digital Control Equipment (DDC) as required by the point list, plans, and specifications including, control units, software, database development, check-out, and debugging. Provide points necessary for a complete and operable system.
7. Install the sequence of operations specified in the drawings and in this section.
8. Software testing requirements shall include testing in the field of all logic sequences including actual simulation of different processes and events and observing program response to the process or event. All deviations from the requirements of the sequence

as specified on the drawings or this specification shall be corrected immediately at no additional cost to the Owner.

9. Provide documentation of software system testing before acceptance testing.
10. Provide staff for acceptance testing procedures. Modify hardware and software errors/problems at no additional cost to the Owner.
11. Provide a series of training classes for Owner staff.
12. Setup trending data before and after system acceptance.
13. Attend a series of meetings with the Engineer and Owner to agree on system setup and operating parameters.
14. Provide detailed documentation of system configuration including control units and all control devices.
15. Read this section in it entirety for specific details.
16. If the Control Contractor can not comply with any of these specifications, then the Control Contractor must explain in writing the reasons for non-compliance and provide an alternative approach that satisfies these requirements.

1.5 QUALITY ASSURANCE

A. The BAS system shall be designed, installed, commissioned, and serviced by qualified contractor.

B. Acceptable control system manufacturer includes Johnson Metasis .

C. All products proposed for this contract shall have been in continuous and successful use for at least two (2) year (not including beta testing).

D. All materials and equipment used shall be standard components, regularly manufactured for this and/or other systems and not custom designed specially for this project.

E. The control system shall be forward compatible with future versions of the manufacturer's hardware, firmware, and software. Future versions of the manufacturer's hardware, firmware, and software shall be backward compatible with the installed control system. Forward and backward compatibility shall be guaranteed for at least five (5) years from the time of system acceptance. Any hardware, firmware, or software modifications or replacements required within that period because of incompatibility with new hardware, firmware, or software installed in the same facility shall be at no cost to the Owner.

Note: Equipment (controllers and software) should be provided by single manufacturer. All other products (e.g., sensors, valves, dampers, and actuators) need not be manufactured by the control manufacturer.

1.6 CONTROL CONTRACTOR/MANUFACTURER QUALIFICATIONS

A. The Control Contractor shall have an established working relationship with the control manufacturer of not less than five years.

B. The Control Contractor's or Manufacturer's installer and programmer shall have successfully completed control manufacturer's classes on control systems and shall present for review the certification of training.

C. The Control Contractor's or Manufacturer's installer and programmer for this project shall be:
2. The installer and programmer's previous work experiences shall not be less than five years.
3. The installer and programmer shall be technically proficient in both control systems and mechanical (air handling units, boiler, and chiller) systems.

4. Installer and programmer's references (including contact names and phone numbers) from all jobs during the past 12 months shall be presented.

1.7 RELATED SECTIONS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions, Mechanical Special Conditions, Electrical Special Conditions and Division - 1 Specification.

B. Sections apply to work of this section: Section 15050, Basic Mechanical Materials and Methods.

C. Coordination with Other Trades:
1. This section specifies cooperation of the Control Contractor with other trades and Owner's balancing firm to assure proper arrangement of control items. Control valves, dampers, wiring, thermostat wells, and other control devices that are to be built into the field assembled ductwork, piping, or wiring systems shall be furnished by the Control Contractor and installed under other sections of the specification as directed by the Control Contractor and indicated in other portions of the specifications and drawings.
2. The interface between the DDC system and other equipment is the responsibility of the Control Contractor and the Equipment Supplier. The Control contractor shall insure that the DDC system communicates successfully with other equipment (e.g., air handling units, packaged rooftop units, heat pumps, motors, actuators, etc.). Note: the equipment supplier is responsible for the proper performance of their equipment (assuming the proper signal are sent/received from the BAS). The control contractor is responsible for all system sensors, including those which are factory installed.
3. Electrical Wiring: All wiring required for work under this section of the specification shall be provided under this section of the specification unless otherwise specified.
4. Electrical wiring - power for control panels, control devices, and sensors
   a. Power for control units, control devices and sensors shall be coordinated with the air handling manufacturer for the project and/or the Owner.
   b. Contact locations in starter control circuits. All contacts controlling motor starters, including overload contacts, shall be located on the hot side of the coil (un-grounded control power leg). Coordinate this requirement with the air handling manufacturer for the project.
   c. Extend power to damper actuators.
      1) Actuators will be powered at 24 VAC.
      2) At each auxiliary panel location, furnish and install a 24 VAC transformer with 20 VA of capacity for each actuator installed and served from the panel.
      3) Furnish and install a fused terminal in the +24 VAC lead and a disconnecting terminal in the neutral lead of the power cable to each actuator.
5. Testing, Adjusting and Balancing: If necessary, The Controls Contractor shall operate the BAS to assist the TAB Contractor.

1.8 QUALITY CONTROL – CODES AND STANDARDS

A. All work, materials, and equipment shall comply with the rules and regulations of all codes and ordinances of the local, state, and federal authorities. Such codes, when more restrictive, shall take precedence over these plans and specifications, As a minimum, the installation shall comply with the current editions in effect 30 days prior to receipt of bids for the following codes:
1. National Electric Code (NEC)
2. Uniform Building Code (UBC), Oregon Structural Specialty Code
3. Uniform Mechanical Code (UMC), Oregon Mechanical Specialty Code
4. Underwriters Laboratories (UL)
5. National Electric Manufacturers' Association (NEMA)

6. National Fire Prevention Association (NFPA)
7. American Society Of Heating, Refrigeration, And Air Conditioning Engineers (ASHRAE)
8. Instrument Society Of America (ISA)
9. National Institute of Standards and Technology (NIST).

B. Meet all of the local authorities and State Fire Marshal code requirements for normal operating and smoke mode functions.

1.9 DEFINITIONS

A. BAS. Building Automation System is an integrated system that includes automatic temperature controls and energy management control using a DDC system.

B. DDC. Direct Digital Control is a control system that uses electronic signals to control the HVAC systems within a building. Electronic signals are either binary or are converted to analog.

C. Control logic. The control logic or control loop is a strategy used to process inputs and determine an output. The strategy considers all available inputs and considers any limits and conditions that may constrain the output signal.

D. Control logic diagram. The control logic diagram graphically illustrates the control logic.

E. Control unit. Intelligent stand-alone control unit including both primary and secondary units.

F. Primary control unit. A primary control unit is a self sufficient, totally programmable microprocessor-based device (see Parts 3 and 4 for specific details) based on the Primary LAN.

G. Secondary control unit. Secondary control units are microprocessor-based devices (see Parts 3 and 4 for specific details) designed to control terminal devices or packaged equipment. Typically residing on the Secondary LAN.

H. Application control unit. Application control units are dedicated control units that control only one process or control loop.

I. Operator Interface. A device used by the operator to manage the BAS and includes Operator workstation or host computer, portable laptop.

J. Operator workstation or Host computer. The host computer's primary purpose is to enhance man-machine interfacing, enhance reporting, centralized monitoring and control, and provide re-programming capabilities.

K. Portable Operator terminal. Laptop computer used for direct connection to the Control Unit and for remote dial up connection.

L. Engineer shall refer to mechanical design engineer, commissioning agent, or representative chosen by owner.

M. "As-built" documentation means as installed (specifically, after system debugging and system acceptance by the Engineer).

1.10 SUBMITTALS

A. Shop drawing submittals are required for the following, in accordance with Section 15050. The Contractor shall not start the project until the Shop Drawings have been submitted and approved. Shop drawings shall include:

1. All submittals should be provided on paper (with legible font type and size).
2. All drawings should be labeled TC (temperature control) rather than being referenced within the mechanical or electrical divisions. Sheets shall be consecutively numbered
3. One drawing per air handler or system (e.g., boiler plant). Drawing should include point descriptors (DI, DO, AI, AO), addressing, and point names. Each point names should be unique (within a system and between systems). For example, the point named for the mixed air temperature for AHU#1, AHU #2, and AHU #3 should not be MAT but could be named AHU #1, AHU #2MAT, and AHU #3MAT. The point names could be logical and consistent between systems and AHUs. The abbreviation or short hand notation (e.g., MAT) should be clearly defined in writing by the Control Contractor. Naming standard will be decided on during meeting between Engineer, Control Contractor, and Owner (see Section 7.1).
4. Floor plans depicting all BAS control devices (control units, control devices, gateways, LAN interface devices, actuators, sensors, motor control centers, etc.) in relation to mechanical rooms, HVAC equipment, and building footprint. All to be provided in existing front end. One for district laptop computer required.
5. DDC System architecture diagram indicating schematic location of all Control Units, workstations, LAN Interface devices, gateways, etc. Indicate address and type for each Control Unit, Indicate protocol, baud rate, and type of LAN (per Control Unit).
6. For each drawing, include a schematic flow diagram of each air and water system showing fans, coils, dampers, valves, pumps, heat exchange equipment, control devices, etc. Label each control device with setting or adjustable range of control. Label each input and output with the appropriate range.
7. Electrical wiring diagrams shall include both ladder logic type diagrams for motor start, control, and safety circuits and detailed digital interface panel control point termination diagrams with all wire numbers and terminal block numbers identified. Indicate all required electrical wiring. Provide panel termination drawings on separate drawings. Ladder diagrams shall appear on system schematic. Clearly differentiate between portions of wiring that are existing, factory-installed and portions to be field-installed.
8. Show all electric connections of the controls system to equipment furnished by others complete to terminal points identified with manufacturer’s terminal recommendations.
9. Control Contractor shall provide one complete drawing that shows the equipment (fan unit, boiler, chiller, etc.) manufacturers wiring diagram with the control contractors wiring diagram superimposed on it. Supply hard copy.
10. Provide complete panel drawings that are
    a. Clearly labeled.
    b. Drawn to scale
    c. Show the internal and external component arrangement so that the operators can identify the components by their position if the labels come off
    d. Wiring access routes should also be identified so that Class 1 wiring is separated from Class 2 and 3 and so high voltage wiring is segregated from low voltage wiring and tubing.
11. Complete identification of all control devices (manufacturer’s type, number, and function).
12. Damper schedule should include:
    a. Action (normally open or closed)
    b. Direct or reverse actuation
    c. Manufacturer make and model
    d. Design pressure drop at full flow
    e. Leakage rate
    f. Operating range
    g. Flow rate
    h. Actuator requirements
    i. Actuator spring range
    j. Special construction features (U.L. listed smoke damper, etc.)
13. A set of drawings showing the details of the valve and valve actuator installation for each valve, required for operation and maintenance manuals only. This should include:

a. Action (normally open or closed)
b. Manufacturer make and model
c. C_v
d. Close off rating
e. Flow rate
f. Actuator spring range
g. Cavitation coefficient (where applicable)
h. Special construction features

B. Record Documents:
1. Provide a complete set of control drawings with as-installed equipment and operating sequences on paper and in electronic format (AutoCAD). “As-built” (i.e., as-installed and debugged and after system acceptance) documentation shall include the following as minimum:
a. All data specified in the shop drawings section in its final "as-built" form.
b. Schematic outline of the overall control system for quick reference
c. Adequate record of the work as installed, including exact location of control panels and the wiring route (using TC documents, section 1.8-3).
d. Blue prints shall include sequence of operation.
e. System hardware specification data which provides a functional description of all hardware components.
f. System engineering information which provides all of the information for the system set-up, definition and application.
g. System database information that provides the point names and application data programmed into the system.
h. All of the information, data, procedures and drawings shall be supplied in the form of manuals.
2. Provide as-installed (after system acceptance) control logic diagrams showing all points (real and virtual).
3. DDC systems that use line-based programming must reference line code number with control logic diagrams and/or with sequence of operation text. Control Contractor shall discuss final format with owner.
4. Provide licensed electronic copies of all software for each workstation and laptop. This includes, but is not limited to: project graphic images, project database, trouble-shooting and debugging programs, project-specific application programming code and all other software required to operate and modify the programming code (including software at system level, primary control units, secondary control units, and all communication software). Any hardware devices (cables, protection devices) required to operate the software/hardware shall also be provided.
5. The Control Contractor shall document deviations from the shop drawing submittals. Documentation should include what equipment was changed and the reason for the change.
6. Provide copy of final test reports.

C. Operating and Maintenance Materials:

1. Provide Operation and maintenance data on all equipment requiring service or adjustment (prior to and after final acceptance).
2. Provide user guides and programming manuals for all hardware and software.
a. A reference manual shall be furnished and shall contain, as a minimum, an overview of the system, its organization, the concepts of networking and central site/field hardware relationships. It shall be a complete guide to operating all aspects of the software system, including activating the system, use of the mouse, description of all menus, establishing setpoints and schedules, downloading or uploading information to or from field hardware, generating or collecting trends,

alarms and reports, backing up system software and data files and interface with third party software.

b. Manuals for advanced programming (for each controller type and for all workstations) shall be provided.

3. Provide a Bill of Materials with each schematic drawing. List all devices/equipment and match to schematic and actual field labeling. Provide quantity, manufacturer, actual product ordering number, description, size, accuracy, operating ranges (voltage, temperature, pressure, etc.), input/output parameters, etc.
4. Field copies of wiring for Primary and Secondary Control Units. (Laminated and permanently affixed in or above controller).
5. For the equipment not manufactured by the Control Vendor, an alphabetical list of system components with the name, address and 24-hour telephone number of the company responsible for servicing each item during the first two years of operation shall be provided.
6. Operating and maintenance instructions for each piece of equipment that includes:
   a. Emergency procedures for fire or failure.
   b. Start-up, operation, maintenance, disassembly and shutdown procedures.
   c. Maintenance instructions for each piece of equipment.
   d. Proper lubricants and lubricating instructions.
   e. Cleaning, replacement and/or adjustment schedule.
   f. Product data on each piece of equipment, including damper and valve information noted earlier.
   g. Emergency heat instructions.
7. Points list shall include all physical input/output and virtual points. Points list shall be provided in hard copy and shall include:
   a. Name
   b. Address
   c. Scanning frequency
   d. Engineering units
   e. Offset calibration and scaling factor for engineering units
   f. High and low alarm values and alarm differentials for return to normal condition
   g. Default value to be used when the normal controlling value is not reporting.
   h. Message and alarm reporting as specified.
   i. Identification of all adjustable points
   j. Description of all points
8. Control Logic documentation shall include:
   a. Drawings documenting control logic for all aspects of the BAS including control units, controlled devices, sensors, etc.
   b. A detailed sequence of operation (see Part 6) should be submitted on separate sheets for each AHU or HVAC system. The text description of the sequence of operation should include:
      1) Logic control statement (i.e., describe control loop process)
      2) Setpoints and throttling ranges, deadbands, and differentials for temperature and pressure variables, gains, reset schedules, etc.
      3) Limits/conditions and interlocks
      4) Measured variables (e.g., mixed air temperature)
      5) Variables to communicate to/from the network
   c. Control diagrams should identify
      1) System being controlled (attach abbreviated control logic text)
      2) All DO, DI, AO, AI points
      3) Virtual points
      4) All functions (logic, math, and control) within control loop
      5) Legend for graphical icons or symbols
      6) Definition of variables or point names (e.g., OAT = outside air temperature)
      7) Define values (e.g., 1 = on, 0 = off)

8) Voltage, amperage, or resistance input/output signal for all sensors and controlled devices

D. Conformance Certificates: Upon substantial completion of the work, supply and turn over all required inspection certificates from governing authorities to certify that the work as installed conforms to the rules and regulations of the governing authorities.

E. Warranty Certificates:

1. Warrant all work as follows:
   a. Labor and materials for the control system specified shall be warranted free from defects for a period of 24 months after final completion and acceptance. Control system failures during the warranty period shall be adjusted, repaired, or replaced at no additional cost or reduction in service to the owner.
   b. The Control Contractor shall respond to the owner's request for warranty service within 24 hours during normal business hours.
   c. The Control Contractor shall respond to the owner's request for Emergency service during the warranty period within 4 hours.
2. Emergency service shall be available 8,760 hours per year.
4. Emergency service rates for additional assistance shall be provided.
   a. The contractor shall provide unlimited phone technical support to the owner during the warranty period. If the technical support location of the contractor is outside of the toll free calling area for the customer, the contractor shall have a toll free number or accept collect calls for the purpose of providing technical support.
   b. The contractor shall provide technical support bulletin service (if available) for two years.
   d. At the end of the final startup, testing, and commissioning phase, if equipment and systems are operating satisfactorily to the Engineer, the Engineer shall sign certificates certifying that the control system's operation has been tested and accepted in accordance with the terms of the specifications listed in Section 15900 (see 7.3 thru 7.4). The date of acceptance shall be the start of the warranty period.
   e. All work shall have a single warranty date, even when the owner has received beneficial use due to an early system startup.
   f. Operator workstation software, project-specific software, graphic software, database software, and firmware updates which resolve known software deficiencies as identified by the Control Contractor shall be provided at no charge during the warranty period.
   g. Any hardware or software discovered to incorrectly process dates starting January 1, 2000 through the year 2040 shall be replaced by the Control Contractor at no cost to the owner.
   h. Control contractor shall be available for a final check and adjustment of the DDC system before the warranty period ends. The final check will include input from the maintenance staff as well as the Engineer.

1.11 DELIVERY AND STORAGE

A. Provide factory-shipping cartons for each piece of equipment and control device not factory installed. Provide factory applied plastic end caps on each length of pipe and tube. Maintain cartons and end caps through shipping, storage, and handling as required to prevent equipment and pipe-end damage, and to eliminate dirt and moisture from equipment and inside of pipe and tubes. Store equipment and materials inside and protected from weather.

1.12 SURGE PROTECTION

A. All equipment shall be protected from power surges and voltage transients. If failure occurs from surges and transients during the warranty period, then the contractor shall repair surge protection equipment and other equipment damaged by the failure at no cost to the owner.
   1. Isolation shall be provided at all peer-to-peer network terminations, as well as all field point terminations to suppress induced voltage transients, and shall be consistent with IEEE Standards 587-1980.

1.13 DISCREPANCIES

A. Any items not included in the specification but referred to in the Appendix and/or Drawings in reference to this project and any other incidentals not referred to but required as a basic element to the overall performance and/or successful completion of the work shall be installed as part of this contract.

PART 2 – PRODUCTS

2.1 BASIC MATERIALS, CONTROL DEVICES, SENSORS

A. Installation of some of the equipment in this section may be the responsibility of other contractors (see 1.5).

B. All sensors and equipment related to or connected to the DDC system shall be installed according to manufacturer's recommendations.

2.2 WIRING, CABLE TRAYS, CONDUIT, AND HANGERS

A. To supply, install and connect all conduits, boxes and wires between all the different components related in this section including all line voltage to the equipment.

B. Provide all necessary field wiring and devices from the point of connection indicated on the drawings. Bring to the attention of the Engineer in writing, all conflicts, incompatibilities, and/or discrepancies prior to bid or as soon as discovered.

C. Field Wiring: It is the intent of these specifications that all systems shall be complete and operable. Refer to all drawings and specifications to determine voltage, phase, circuit ampacity and number of connections provided.

D. All wiring and fiber optic cable in the central plant, tunnels, and plenums to be supported by B-line Bridle rings or equal. All wiring and fiber optic cable in the hallways, rooms, and other public areas shall be in conduit.

E. All wires in Bridle Rings or conduit shall follow building lines (i.e., wires in plenum space shall run within several inches of the wall and shall NOT run in the middle of the space).

F. Wire:
   1. Wire and cable of the sizes and types shown on the plans and/or hereinafter specified shall be furnished and installed by the Control Contractor. All wire and cable shall be new soft drawn copper and shall conform to all the latest requirements of the National Electrical Code, IPCEA, and shall meet the specifications of the ASTM.
   2. All control wiring to be copper stranded TEW-105, with appropriate gauge in accordance with the Codes. The minimum gauge used to be 16 AWG.
   3. Input/Output Wiring: Wiring serving inputs and outputs from the BAS shall be cables consisting of single or multiple twisted individually shielded pairs. Each pair shall have an independent shield with drain wire. Cables installed with out conduit shall be plenum

rated and comply with NEC article 725. Where automation input/output wiring is run in cable tray furnish and install conductors or multiconductor cable rated for use in cable trays per NEC articles 340 and/or 725. Conductors shall be minimum #18 wire gauge.

4. Power Conductors: All feeder and branch circuit wire shall be 600 V insulated of THHN type unless shown or specified to be otherwise. No wire less than No. 12 gauge shall be used except for control circuits or low voltage wiring. Wire sizes No. 14 to No. 10 shall be solid except where otherwise indicated. Wire sizes No. 8 and larger shall be stranded. All wire sizes shown are American Wire Gauge sizes. Where power conductors are run in cable tray, furnish and install conductors or multiconductor cable rated for use in cable trays per NEC articles 340 and/or 725.
5. All the conductors used for signals from the Controllers and field sensors must be shielded two wire, 18 AWG. with a drain wire. Conductor model 8760 from Belden is to be used or approved alternative by Engineer.
6. All power wiring to be copper stranded RW 90 type, with appropriate gauge in accordance with the Codes. The following color code must be applied: line voltage to be black and/or white, ground to be green.
7. Acceptable Manufacturers: Cable and wire shall be a standard type as manufactured by General Electric Company, National Electric Company, U. S. Rubber Company, Simplex, General Cable Company, Carol, Anaconda, Rome, Southwire, Belden, Alpha, Houston Wire and Cable, or ITT Royal.

G. Wiring Installation:
1. All wires shall be continuous from outlet to outlet and there shall be no unnecessary slack in the conductors.
2. All wire terminations will be identified using rail terminal strips (see 5.10)
3. All drain wires must be grounded at the source end. The other end must be protected with a dielectric material (tape).
4. All control wiring (24 V and more) must be in a separate conduit from the shielded conductors.
5. Pull-Box and Junction Box:
   a) Pull boxes and junction boxes shall be installed where indicated on the drawings or where required to facilitate wire installation. Locate in conjunction with other trades so as to install without conflict with other materials or equipment.
   b) A pull-box will be located at every 50'.
   c) All switch, pull, junction boxes, etc., shall be hot dipped galvanized or sherardized, concrete tight, with interlocking ring or multiple point locking devices. Connectors shall be three piece. Indentation fittings are not acceptable.
   d) In suspended ceilings, all boxes must be installed on the structure.
   e) Boxes shall be attached by fasteners designed for the purpose and shall provide adequate mechanical strength for future maintenance.
   f) Junction and pull boxes not dimensioned shall be minimum 4 inch square.
6. Care shall be used to avoid proximity to heat ducts and/or steam lines. Where crossings are unavoidable, conduit shall clear covering of line by at least six inches.
7. Motor Interlock Wiring: Interlock circuit wiring shall be No. 14 solid or stranded wire. Stranded wire only shall be used where wiring is used for flexible wiring harnesses. Stranded control wire shall be provided with crimp type spade terminators. Interlock circuit wiring shall be color coded or numbered using an identical number on both ends of the conductor. Wire numbers shall be installed before conductors are pulled. Where motor interlock conductors are run in cable tray, furnish and install conductors or multiconductor cable rated for use in cable trays per NEC articles 340 and/or 725.
8. All splices, taps, and terminations shall be made at outlet, junction, or pull boxes. Wire to No.6 gauge shall be spliced using Scotchlok wire nuts. No Bakelite wirenuts shall be used. Wire No. 6 and larger shall be spliced using solderness connectors as manufactured by Penn Union Company. Splices No. 6 and larger shall be insulated by taping with plastic vinyl tape as manufactured by Minnesota Mining and Manufacturing Company. Splices shall not be permitted in automation input and output wiring with out

specific written authorization from the Engineer. If such a splice is approved, the location of the splice shall be clearly documented on the "As Built" drawings. Splices in automation wiring, if necessary, shall be made using Thomas&Betts STA-KON connectors installed per the manufacturers directions to maintain NEMA specified voltage drops and wire retention forces.

9. Grounding:
   a. The contractor shall extend existing equipment grounding systems. The Contractor shall use only approved grounding clamps and connectors as manufactured by Penn-Union, Burndy or O-Z Mfg. Company.
   b. The conduit system of the 480/277 and 208Y/120 volt systems shall be continuous and shall be used as the static grounding conductor, except for circuits installed in flexible conduit. Install a green grounding conductor inside all flexible conduits and extend to the nearest outlet or junction box. Install a green grounding conductor inside all non-metallic conduits or raceways.

H. Conduit:

1. Conduit Material:
   a) All wiring to be in E.M.T. type conduits unless in plenum.
   b) All conduits to be a minimum of 1/2".
   c) All flexible conduits will not exceed 6' in length and are to be used only in areas where vibrations and/or expansion joints are present.
   d) Flexible conduit to be used for connecting any element to its conduit. The length of this flexible conduit will not exceed 24".
   e) Jacketed flexible steel conduit (Sealtite) shall be used where flexible conduit connections are required and at connections to all motorized equipment and motors.
   f) In damp areas, the conduit and related equipment must be suitable for the application.
   g) Electrometalic tubing shall be installed for all exposed work and for all concealed work in applications where conduit is required.
   h) Conduit shall be by Allied, Triangle, Republic, Youngstown, Carlon, Rob Roy, or approved equal.

2. Conduit Installation:

   a. All wiring in mechanical rooms at heights below 12 feet must be run in conduit. Otherwise, wiring in all other open areas must have conduit (at all heights).
   b. All conduits to be installed in a concealed manner where possible and shall be installed parallel to the lines of the building.
   c. All exposed conduits shall be installed parallel or at right angles to the building walls or floors.
   d. Conduit bends shall be made with standard hickeys of proper size; radius of bends to be at least 6 times the diameter of the conduit. Runs between outlets shall not contain more than the equivalent of three quarter bends. Conduit runs shall be continuous from outlet to outlet, outlet to cabinet, etc.
   e. Conduits shall be installed with pitch toward outlet box wherever possible. All heavy wall conduits shall have two locknuts and a bushing at each termination outlet box, junction box, etc., except where terminated in a threaded hub. Fittings on electrometalic tubing shall be compression type.
   f. A bushing shall be used where conduit enters a panel box. Bushing for No. 4 AWG or larger shall be insulated type with provisions for grounding as type "BL" made by O-Z Electric Company, or approved equal.
   g. Expansion fittings shall be provided at all conduits across the building expansion joints. Fittings shall be Type "AX" or "TX" as made by O-Z Electric Company, or approved equal. Provide copper bonding jumper at each expansion fitting.

h. All ½'' conduit to be supported every 6', the supports will be located at the connector end of the conduit.
i. Exposed conduit shall be securely fastened in place on maximum 5 ft. intervals for 3/4" through 2-1/2 inch nominal sizes. Supports may be one hole malleable straps or other approved devices. No perforated metal straps will be permitted.

I. Wireway:

1. Furnish and install at all control panel locations a NEMA 1 lay-in wireway system to bring cable into and out of the panel as detailed on the drawings and specified in this section. Furnish 3-way wireways at each panel location: one for Class 1 wiring, 1 for Class 2 and Class 3 wiring. Panels at units to be NEMA 3R or better.
2. Wireway systems at locations where cables are to be run without conduit or in a cable tray shall consist of a connection to the control panel with a vertical extension to 8'-0" or the pipe rack or cable tray level, whichever is higher. The vertical section shall terminate in a 90° fitting with a closure plate. The closure plate shall be provided with a conduit nipple with locknuts and bushings as a wire entry point into the square duct. The conduit nipple shall be one size smaller than the wireway it is associated with.
3. Wireway systems at locations where cables are to be run in conduit shall consist of a horizontal section of wireway with a length equal to the control panel width and located above the control panel and connected to the control panel with three conduit nipples, locknuts, and bushings; one for tubing, one for Class 1 wiring and one for Class 2 and 3 wiring. Conduits for cable runs shall terminate on the wireway.
4. The intent of the wireway configurations outlined above is to provide a method for adding input and output wiring to the control panel without having to drill directly into the electronics enclosure after the system is on-line and running and to provide sufficient area to land field conduits while maintaining appropriate circuit segregation for wire entry into the controller enclosure. The installation of wireway shall be made with this consideration in mind.

J. Hangers and Anchors:

1. Where control system tubing is run on trapezes and/or hangers used by and or installed by other trades, supports for the trapezes shall be coordinated by all trades using the trapeze to assure that the anchor system is not overloaded and is sufficient for the load imposed including a margin of safety and seismic considerations. Under no circumstances shall a trapeze or hanger system installed by the electrical trades be used to support work by any other trade, nor shall the electrical trades use the trapezes installed by any of the other trades for the support of electrical equipment, all as required by the National Electric Code. Similarly, under no circumstances shall a trapeze or hanger system installed by the sprinkler trades be used to support work by any other trade, nor shall the sprinkler trades use the trapezes installed by any of the other trades for the support of sprinkler systems or equipment, all as required by NFPA 13, Standard For The Installation Of Sprinkler Systems.
2. Anchors to be loaded in tension for use in existing concrete structure and anchors loaded in tension and not cast in place shall be epoxy resin set anchors installed per the manufacturers recommendations for technique, size, loading, embedment, etc. Where anchors are loaded in shear at these locations, suitably sized and installed wedge type anchors may be used.
3. In all cases, anchor loading shall be based on hanger spacing, weight of the pipe to be supported when full and insulated, weight of any additional loads imposed upon the anchor, wind loading, seismic loading, quality of the material that the anchor is being installed in, etc. The Control Contractor shall verify in the field that the anchors used and the materials that they are being installed in are suitable for the load imposed and shall bring any problems to the attention of the Engineer in writing immediately and not proceed without direction from the Engineer.

4. Wedge type anchors shall be Hilti Kwik Bolt II. Adhesive anchors shall be Hilti HVA.

2.3 UNIT CONTROL PANELS (INSTALLATION AND FABRICATION)

A. Enclosed cabinet type with hinged door for mounting all relays, switches, thermometers, and miscellaneous controls not requiring direct mounting on equipment such as sensing elements, valves and damper motors. Provide cabinet for each control unit adjacent to each system.

B. Each panel shall have power conditioners on electrical supply, as required by the manufacturer.

C. Control panels shall be fabricated to match the approved shop drawings submitted by the control contractor. Fabrication shall be in a neat and workmanlike manner and shall facilitate repair, maintenance, and adjustment of the equipment contained therein.

D. Control panels shall be fabricated and laid out to incorporate the following features:
1. Identification of all internally and cover mounted devices. Cover mounted labels shall be engraved labels as specified in this section (5.10). Labels shall be mounted adjacent to the device they are associated with so that replacement of the device does not eliminate the label. Provide laminated control diagram at each panel.
2. Electrical wiring shall enter the panel from the top, bottom, and/or side of the left side of the panel or as required by the panel supplier to meet NEC requirements.
3. All wires entering or leaving the panel shall pass through a rail terminal strip. Where the wires are part of a current loop transmission circuit, the terminals shall be the disconnecting link type. Terminals shall be identified with a number that corresponds to the terminal number on the job wiring diagram. Rail terminal strip specifications include:
   a. General: Terminal rail assemblies shall be fabricated from components selected from the product line of one manufacturer. Sizes (heights, widths, and profiles) of each terminal shall be selected to be compatible with the other terminals on the rail. Terminal units located at the end of a rail or adjacent to terminals with a different profile (for example, where disconnecting terminals are located next to resistor terminals) shall be provided with end caps to completely close off the terminal unit interior components from the local environment. End stops shall be provided for on all rails to secure the terminals located on the rail in place.
4. All internal wiring and tubing shall be run inside plastic wiring/tubing duct as manufactured by Tyton. Wire duct shall be sized to hold the required number of wires and tubes without crimping the tubes and with sufficient space to allow wiring and tubing to be traced during troubleshooting operation.
5. Wires that pass from the panel interior to cover mounted devices shall be provided with a flex loop that is anchored on both sides of the hinge. Wiring running to cover mounted devices shall be bundled using cable ties.
6. Provide strain relief type cord and cable connectors for all cables that leave the panel as individual cables not in conduit.
7. All control panels shall be provided with removable sub panels to allow the panel enclosures to be installed at the job site during rough in while the panels are fabricated off-site for later installation.
8. Provide one duplex outlet mounted inside the control panel and separately fused with a non-time delay fuse at 15 A at any panel location containing electronic or electrical control components. This receptacle may be served from the control panel 120 VAC power source.
9. Each control panel shall be provided with a control power disconnect switch located and wired so as to disconnect all control power in the panel. The leaving side of this switch shall be wired to the panel and field components through a fuse or fuses sized and applied to protect both the components of the system as well as the wire and as required for code compliance.
10. Power to the following equipment will be have a fuse rated for applicable current and voltage. Fuses will be on rail terminal strips. Equipment includes:

a. Each control unit
b. Control devices
c. Panel light
d. Receptacle loads (e.g., modems, laptops)

11. All control panels containing electrical equipment shall be NEMA rated for the location in which they are installed. Cover mounted components, tubing penetration, and conduit penetrations shall be made in a manner consistent with the NEMA rating.
12. All wiring leaving the panel shall be separated by classification; i.e., Class 1 circuits shall not be run with Class 2 circuits, etc. Segregation shall be maintained inside the panel to the fullest extent possible. Where low voltage wires carrying low level ac and dc signals cross wires containing power and high level ac signals, the wires shall cross at a 90° angle.

E. Control panels shall be shop fabricated and tested prior to installation in the field. The panels shall be inspected and approved by the Engineer at the assembly location prior to installation in the field. The Engineer shall be given the opportunity to witness the testing of the panels.

F. Panel Location:
1. Each control panel is to be located for convenient servicing.
2. Mount panels adjacent to associated equipment on vibration isolation.

2.4 CONTROL VALVES AND ACTUATORS

A. Provide adequate size and number for modulating or two-position action.

B. Provide positive positioning devices where shown or where sequencing cannot be accomplished by using standard spring ranges.

C. Valve Sizing:
1. Modulating valve sizing shall be based on the following conditions.
a. Water Valves:
1) Minimum pressure drop - 3 psi or equal to the water side pressure drop of the coil it is associated with, which ever is greater.
2) Maximum pressure drop - 5 psi
b. Flow rates for valve sizing shall be based upon the flow rates indicated on the equipment schedules on the drawings.
c. Valve sizing shall consider the valve cavitation coefficient. In no case shall a valve be sized so that the pressure drop through the valve causes cavitation with fluid temperatures and pressures encountered in the system during start up or normal operation.
d. Valves on heating systems to be normally open.

D. Valves: Belimo.

1. Equip with modulating plug or V-port inner valve with composition disc for tight shutoff.
2. Two position valves shall be the full size of the pipe that they are associated with unless otherwise specified.
3. Two-way valve actuators shall be sized to close off tight against the full pump shut off head on the system upon which they are installed.
4. Three-way valve actuators shall be sized to close off tight in both directions against 2.5 times the valve pressure drop at full flow.
5. Valves shall close against differential pressures. Water control valves, acting as pressure control or pressure relief valves, shall be capable of closing against a differential pressure equal to 150% of rated pump head of each application.
6. Provide spring returns on valve operators so that the valves fail safe during electrical power failure in normally open or closed position as specified and/or shown on drawings.

NOTE: the actuator shall be wired to close the valve using the electric motor only. Spring return is to be used only in the advent of an electrical power failure.

7. Two-position steam valves.
   a. Steam control valves shall be single seated with equal percentage flow characteristics. If required for equal percentage flow characteristics, multiple valves may be used.
   b. Valve discs shall be composition type with stainless steel trim for steam pressure greater than 35 psi.
8. Screwed ends on valves 2-inches and smaller. Flanged ends on valves 2-1/2 inches and larger.
9. Three-way valves where indicated on Drawings, otherwise two-way valves.

E. Valve Actuators:

1. Electronic actuators shall be manufactured by Belimo for valves larger than ¾". For valves smaller than ¾", Johnson, Siebe or Approved.
2. Torque shall be rated at twice the required load.

2.5 CONTROL DAMPER ACTUATORS

A. Damper Actuator Requirements:

1. All damper actuators shall be Belimo electric actuators. The only exception to this is for VAV damper controllers, Siebe is approved. No other shall be accepted.
2. Torque rating shall be based on the damper manufacturers operating torque requirements at the design flows and pressure drops or shall be based on the manufacturers required shut-off torque to achieve the design leakage rate, which ever is greater. This higher torque rating shall be doubled. An actuator with this doubled torque rating shall be installed.
3. All damper sections which operate in sequence with each other shall have identical actuators and identical linkage arrangements to assure similar performance between all sections.
4. Modulated actuator operation shall be industry standard 0-10 VDC, 4-20 mA.
5. Two or three position operation is not acceptable for economizers, VAV dampers, multizone dampers, or any other application specifying modulated operation. OSA Dampers to be normally closed, mixed air dampers to be normally open.
6. Actuator quantities for dampers shall be based on the following criteria.
   a. Actuators must be outside unit enclosure.
   b. Actuators shall be installed to maximize the linearity between actuator stroke and actuated devise travel (25% actuator stroke produces approximately 25% of the desired angular rotation required; 50% stroke produces 50% angular rotation). In addition, actuators should be installed to maximize force available for useful work over the entire stroke.

2.6 SENSORS

A. All sensing inputs shall be provided industry standard signals.

B. Temperatures, humidities, differential pressure signals, and all other signal inputs shall be one of the following types:
1. 0 - 20 mA
2. 4 - 20 mA
3. 0 - 5 VDC
4. 0 - 12 VDC
5. 1000 ohm RTDs

C. All signal inputs shall be compatible with the controllers used and with the requirement for readout of variables as specified.

D. If sensors are not linear, then software will linearize sensor output.

E. Minimum sensor accuracy (as compared to a test standard) and range are listed in Table. Accuracy is not the same as resolution (the ability of the DDC to measure incremental change). Resolution is specified in "Part 3. DDC Hardware."
   1. All accuracy values should be combined effect numbers taking into account thermal drift, interchangeability, hysteresis, etc.

Sensor Type	Range	Min. Accuracy
Duct/Air Handling Unit Temperature	40 – 130°F	± 0.5 Degree F
Room Temperature	50 – 85°F	± 1 Degree F
Outside Air Temperature	- 20 to 120°F	± 0.5 Degree F
Chilled Water Temperature	32 – 80°F	± 0.1 to ± 0.5 Degree F
Hot Water Temperature	80 – 220°F	± 0.1 to ± 0.5 Degree F
Water flow	Sized for application	± 5% of reading
Humidity	0 to 100% RH	± 3% RH
Duct Static Pressure	0 to 3″ w.c.	± 1% full scale per 50°F
Space Static Pressure	- 0.25″ to 0.25″ w.c.	± 1% full scale per 50°F
Steam Pressure	Sized for application	± 1% full scale
Current Sensor	Sized for application	± 1% full scale
Power (kWh)	Sized for application	± 2.5% full scale (at 0.5 PF) ± 2% full scale (at 1. PF)
Air flow	700 to 4,000 fpm	± 2% full scale
CO_2 sensors	0 to 2,000 PPM	± 3% full scale
Propane	20% to 40%	± 5%
Freeze Stat	34ºF to 68ºF	± 1ºF

Sensors shall not drift more than 1% of full scale per year

2.7 TEMPERATURE SENSORS/THERMOSTATS

A. All sensors shall be completely electronic.

B. Duct/ Air Handling Unit type temperature sensor (mixed, discharge/supply, and return air):
   1. The probe of the duct sensor shall be 12" in length, and be made of Stainless Steel. Applications where the smallest dimension of the duct is less than 24", the probe shall be sized to reach the center of the duct.
   2. Large systems above 9 square feet may require an averaging probe if sufficient mixing of the air stream is not possible.
   3. Mount the sensor far enough down stream to allow mixing of the air stream, this is most important on Hot and Cold Deck applications where the coil is placed after the fan.
   4. Sensors for mounting on insulated ducts or casings are to be equipped with brackets for mounting clear of the isolation.
   5. Do not locate sensors in dead air spaces or in positions with obstructed air flow.
   6. Provide separate duct flange for each sensing element.
   7. Temperature sensing elements shall be thermally isolated from brackets and supports.
   8. Securely seal ducts where elements or connections penetrate duct.
   9. Mount sensor enclosures to allow for easy removal and servicing without disturbance or removal of duct insulation.

C. Outside Air Type Temperature Sensor:
   1. The enclosure shall be weatherproof and complete with PVC sun shield.
   2. The enclosure shall be located near air intake.
   3. The enclosure shall not be located near exhaust fans or ducts.

D. Immersion Type Temperature Sensor:
   1. The probe of the sensor shall be constructed of stainless steel and pressure rating consistent with system pressure and velocity.
   2. The well shall be constructed of stainless steel and sized to reach into the center of the pipe. Pipes with small diameters shall have the well mounted at a 90 degree elbow to allow sufficient contact with the fluid.
   3. Locate wells to sense continuous flow conditions.
   4. Do not install wells using extension couplings.
   5. Wells shall not restrict flow area to less than 70 percent of line-size-pipe normal flow area. Increase piping size as required to avoid restriction.
   6. Provide thermal transmission material within the well.
   7. Provide wells with sealing nuts to contain the thermal transmission material and allow for easy removal.

E. Room Type Temperature Sensor:
   1. All thermostat locations shall be submitted for approval before installation.
   2. Provide all sensors with blank wall plate, vandal-proof covers that are flush with wall. Provide with slide bar adjustments. Sensor temperature adjustment range to be programmed for range.
   3. Unless otherwise noted, zone temperature sensors shall be thermistor type and have network communication plug type connections for local connection to the network.
   4. Coordinate sensor location with light switches, and mount 60" above the floor. Verify location before installation, so that no direct sunlight or influences from heat and cooling sources will be imposed on the sensor.
   5. Unless otherwise indicated or specified, provide one discharge and one space temperature sensor for each VAV Terminal Control Unit.
   6. Metal guards shall be provided as shown on Drawings.
   7. Insulation shall be installed between the temperature sensor and open conduit to eliminate false temperature readings due to cold drafts.

F. Freeze Stat: 20’ element (copper capillary), manual reset, SPDT Device. Alarm output required.

2.8 HUMIDITY SENSORS

A. The transmitter shall be a two wire type and provide a 4-20 mA signal which is proportional over the 0-100 % range.

B. The transmitter shall be capable of operating from an unregulated 18-30 VDC power supply. Subjecting the sensing element to direct contact with moisture shall not damage the sensing element.

C. Sensors for mounting on insulated ducts or casings are to be equipped with brackets for mounting clear of the isolation.

D. Outside sensor enclosure shall be weatherproof and complete with PVC sun shield. Unit shall be at north side of building away from ducts, heat sources, etc.

2.9 AIR PRESSURE SENSORS

A. Static Pressure and Velocity Controllers:

1. Static pressure sensors shall be of either the diaphragm or rigid element bellows, electronic type, photo helic.
2. Each sensor shall be provided with connections, i.e., stop cock and tubing, for attaching a portable pressure gauge.
3. Sensors for mounting on insulated ducts or casings are to be equipped with brackets for mounting clear of the insulation.
4. The transmitter shall be a two-wire type and provide a 4-20 mA signal which is proportional and linear over the calibrated pressure range.
5. The transmitter shall be capable of operating from an unregulated 18-30 VDC power supply.
6. The device housing shall provide 1/4" barbed brass fitting for the connection of the pressure lines. Pressure ranges shall suit the application so that normal operation will occur at mid range of the sensor span.
7. The location of the indoor measurement shall be remote from doors and openings to the outside, away from elevator lobbies, and shielded from air velocity effects. See Drawings for location.

2.10 WATER AND STEAM PRESSURE SENSORS

A. The device shall be capable of with standing an over pressure of two times its calibrated span with out any damage to the sensing element.

B. Typical ranges: 0-150 psig

C. The device enclosure shall be a NEMA 4 type and provide rugged mounting feet. All wetted parts shall be stainless steel so that a wide variety of fluids may be measured.

D. The transmitter shall be capable of operating from an unregulated 18-30 VDC power supply.

E. Pressure sensors for liquid or pressurized applications shall be installed with shut off valve to that the system must not be shut down or drain to install or service the sensor.

2.11 FREEZE PROTECTION THERMOSTAT

A. Length: one linear foot of sensing element per square foot of coil or duct area.

B. Low temperature cutout control, snap acting, normally closed contacts.

C. Sensing element contacts will open when any 16-inch portion of the element sensing at or lower than setpoint.

D. Manual reset.

E. Temperature sensing elements shall be thermally isolated from brackets and supports.

F. Reset temperature 5°F above setpoint.

2.12 TRANSFORMERS

A. Transformers selected and sized for appropriate VA capacity and installed and fused according to applicable Codes.

2.13 CO_2 SENSORS

A. Sensor output shall be 4-20 mA which is proportional over the specified range.

B. The transmitter shall be capable of operating from an unregulated 18-30 VDC power supply.

C. Sensors shall be field adjustable via the DDC system.

D. Self-calibrating sensors are preferred. Manual calibrated sensors should not require annual calibration but may require calibration every 3 – 5 years. Allow for easy calibration with test gas.

E. Provide CO_2 calibration tool with system. Turn over to owner after calibration and provide instructions on use.

2.14 CURRENT SWITCHES

A. The status of all non–VFD fan and pump motors and all VFD fan and pump motors less than 20 HP shall ONLY be detected using current switches.

B. The current switch shall be provided for electrical equipment status applications only.

C. Switch should attach directly to the conductor and have a mounting bracket for installation flexibility.

D. The current switch shall be 100% solid state electronics.

E. The current switch shall be induce powered from the monitored load

2.15 CURRENT SENSORS/TRANSFORMERS

A. The status and amperage of all VFD motors for fan and pumps shall be detected using current sensors ONLY. A local server with switched output is acceptable.

B. Duct and Plenum Mounted Sensor Probes

1. Sensor probes shall be constructed of gold anodized aluminum alloy tube with 304 stainless steel mounting brackets. Probes shall be constructed as insertion, internal, or standoff mounting, depending on the installation requirements.
2. Probe Performance Requirements: The sensor accuracy for airflow shall be better than +/- 2% of reading over the sensor probe operating ranges. The installed total accuracy for airflow shall be better than +/- 3% of Reading (+/- 6% for stand-off mounted probes) over the sensor probe operating ranges when installed in accordance with manufacturers' guidelines. The sensor accuracy for temperature shall be better than +/- 0.15º F over the entire operating range.
3. Probe Sensor Density:

Area (sq.ft.)	Sensors
<=1	2
>1 to <4	4
4 to <8	6
8 to <12	8
12 to <16	12
>=16	16

4. Probe Operating Ranges: Airflow 0 to 5,000 FPM, temperature –20º F to +160º F, relative humidity 0 to 99% (non-condensing).
5. Provide 18" minimum 20-gauge stainless steel duct extension from outside air intake louver. Mount sensor as recommended by manufacture.

C. Approved Manufacturers and Equipment: EBTRON Gold Series model GTA116-PC or approved.

PART 3 - DIRECT DIGITAL CONTROLS – HARDWARE

3.1 SYSTEM ARCHITECTURE

A. Local Area Network (LAN) linking the primary, secondary, and application control units with the host computers for central reporting and system communication.

B. Host computers shall be located in school where directed by district.

C. The system shall be configured as a distributed processing network(s) capable of expansion as specified in this section.

D. The system architecture shall consist of a multi-level Local Area Network (LAN) which supports Control Units, networked Operator Workstations, and LAN Interface Devices. The following indicates the functional description of the system structure.

1. Interbuilding LAN: Used for communication between Network Controller Modules (network control modules) located in each building, and networked Operator Workstations located at District maintenance headquarters. This LAN will consist of using the existing School District Ethernet backbone with TCP/IP protocol. School District will provide Ethernet connection only. BAS/DDC workstations and the Network Control Module shall employ native TCP/IP protocol with the Ethernet 10BaseT (IEEE802.3) physical layer standard for connection to Ethernet/ATM routers. BAS/DDC workstations shall not require third party routers, gateways or translators for TCP/IP protocol; also IP tunneling shall not be acceptable.
2. Primary Controller LAN: Used to connect Primary Control Units (Primary Control Units-which generally control central plant equipment, air handlers) within a building. This LAN may be Ethernet 10BaseT (IEEE802.3) or a separate high speed peer-to-peer LAN.
3. Secondary Controller LAN: polling or peer-to-peer LAN to support Terminal Control Units/application specific controllers and interfaces to other third party LANs. The Secondary Controller LAN shall interconnect with the Primary Controller LAN using a LAN Interface Device which may or may not be an integral part of a Primary Control Unit.
4. Auto Answer/Auto Dial modem support, operating at a minimum of 56K baud, to allow communication between remote buildings (buildings that do not have campus Ethernet backbone service) and all Operator Workstations on the Interbuilding LAN or primary LAN.

E. Dynamic Data Access: Any data throughout any level of the network shall be available to and accessible by all other devices, Control Units, LAN Interface Devices, and Operator Workstations whether directly connected (via campus ATM backbone) or connected remotely (via dial-up telephone lines) and via the world wide web.

F. The communication speed between the Control Units, LAN interface devices, and operator interface devices shall be sufficient to ensure fast system response time under the maximum future loading condition.

G. The communication speed between the Control Units, LAN interface devices, and operator interface devices shall be sufficient to ensure fast system response time under the maximum future loading condition. In no case shall delay times between an event, request, or command initiation and its completion be greater than the following. Contractor shall reconfigure LAN as necessary to accomplish these performance requirements. Requirements do not apply when a remote connection must be established via dial-up modems.

1. 5 seconds between a Level 1 (critical) alarm occurrence and enunciation at operator workstation .
2. 10 seconds between a Level 2 alarm occurrence and enunciation at operator workstation.
3. 20 seconds between a Level 3-5 alarm occurrence and enunciation at operator workstation.
4. 10 seconds between an operator command via the operator interface to change a setpoint and the subsequent change in the controlling Control Unit.
5. 5 seconds between an operator command via the operator interface to start/stop a device and the subsequent command to be received at the controlling Control Unit.
6. 10 seconds between a change of value or state of an input and it being updated on the operator interface.
7. 10 seconds between an operator selection of a graphic and it completely painting the screen and updating at least 10 points.

H. Polling Secondary LANs shall operate at a minimum baud rate of 9600 baud.

I. The Operator Workstations shall provide for overall system supervision, operator interface, management report generation, alarm annunciation, remote monitoring and back-up and loading of software and data to be stored in control unit volatile memory.

J. The primary and secondary control units shall monitor, control, and provide the field interface for all field points. Each Primary Control Unit or Secondary Control Unit shall be capable of performing DDC functions independent of other Primary Control Units or Secondary Control Units and operator interface devices.

K. Interruptions or fault at any point in the primary LAN shall not interrupt communications between other nodes on the network. If a primary LAN is severed, two separate networks shall be formed and communications within each network shall continue uninterrupted.

L. All gateways, modems, line drivers, signal boosters, and signal conditioners etc. shall be provided as necessary for proper data communication.

M. Anytime any control unit’s database or program is changed in the field, the controller shall either be capable of automatically uploading the new data to the system operator interface, or shall report an error condition on the graphic workstation screen if the workstation program or database does not match the control unit’s program or database.

3.2 PRIMARY CONTROL UNITS

A. Primary control units are stand-alone units able to control HVAC equipment per the specified sequence of operation.
1. Each controller shall be capable of performing all specified control functions independently. The primary control unit shall directly control all units, fans, and control devices. All control software shall be implemented in the primary control unit. The sequence of operation precisely identifies all points of monitoring and control.
2. Shall monitor specific analog and digital inputs, process the data received, and produce analog or digital outputs to control the systems specified.
3. Systems utilizing controllers that operate in a default mode only as a stand-alone will not be acceptable.

B. Minimum specifications include:
1. Microprocessor-based controllers, fully equipped with power supply, input and output terminals, internal (electronic) timeclock, and self-charging battery backup.
2. Modular multi-tasking microprocessor based direct digital controller with minimum of 1MB of EEPROM and RAM memory.
3. Minimum 10 bit Analog-to-Digital (A/D) converter.

4. Minimum 12 bit Digital-to-Analog (D/A) converter.
5. Sufficient memory for storing 288 trend values for every point (real and virtual).
6. Controllers shall have unused physical points available for future add-ons. The number of spare points shall equal 20% of all physical points or two spare points whichever is greater.
7. Shall include all control strategies listed in “Part 4: DDC Software.”
8. Each control loop shall be fully definable in terms of inputs and outputs that are a part of the control strategy.
9. Each control unit shall be equipped with a RS232C communication interface connection, minimum of 16 universal analog or digital inputs and outputs, and shall communicate via the LAN to the host computer.
10. On board power supply for all sensors.
11. On board sockets for plug-in resistors.
12. Each control units shall be capable of proper operation in an ambient environment of between 32°F and 110°F and from 10% to 90% RH.
13. Control units provided for outside installation shall be capable of proper operation in an ambient environment of 0°F to 120°F, and 5 to 95% RH. If such hardware is not available, locate hardware in an accessible indoor location or as approved by the Engineer.

C. Local Area Network (LAN) linking the primary control unit with the host computer for central reporting and system communication. Communication with other primary control units, secondary control units, and application control units shall be within acceptable time limits to ensure continuous operation of all control strategies. Reporting shall be in real time.

D. Primary control units shall be installed on:
1. Air handling units greater than 2,000 CFM
2. Air handling units with VFDs
3. Any application not listed in secondary and application control units.

3.3 SECONDARY CONTROL UNITS

A. Secondary control units are able to control HVAC equipment per specified by the sequence of operation.
1. Each controller shall be capable of performing specified control functions. The secondary control unit shall directly control all units, fans, dampers and control devices. All control software shall be implemented in the secondary control unit. The sequence of operation precisely identifies all points of monitoring and control.
2. Each controller shall monitor specific analog and digital inputs, process the data received, and produce analog or digital outputs to control the systems specified.

B. Minimum specifications include:

1. Microprocessor-based controllers, fully equipped with power supply, input and output terminals.
2. Modular multi tasking based direct digital controller with minimum of 2048 bytes of EEPROM and RAM memory.
3. Minimum 8 bit Analog-to-Digital (A/D) converter.
4. Minimum 10 bit Digital-to-Analog (D/A) converter.
5. Controllers shall have unused physical points available for future add-ons. The number of spare points shall equal 20% of all physical points or two spare points each, whichever is greater for UI (Universal Input), DO (Digital Output), and AO (Analog Output).
6. Shall include all control strategies listed in “Part 4: DDC Software.”
7. Each control loop shall be fully definable in terms of inputs and outputs that are a part of the control strategy.

8. Each secondary control unit shall be equipped with a RS232C communication interface connection, minimum of 16 universal analog or digital inputs or outputs, and shall communicate via the LAN to the host computer. Each control units shall be capable of proper operation in an ambient environment of between 32°F and 110°F and from 10% to 90% RH.
9. Control units provided for outside installation shall be capable of proper operation in an ambient environment of 0°F to 120°F, and 5 to 95% RH. If such hardware is not available, locate hardware in an accessible indoor location or as approved by the Engineer.

C. Local Area Network (LAN) linking the secondary control unit with the primary control unit for central reporting and system communication. Communication with primary control unit shall be within acceptable time limits to ensure continuous operation of all control strategies. Reporting shall be in real time.

D. Secondary control unit. Secondary control units are microprocessor-based devices that are less programmable and will be used on:

1. Small unitary equipment (flow rate less than 2,000 CFM)
2. Fan coil units
3. Heat pumps
4. Unit ventilators

PART 4 - DIRECT DIGITAL CONTROLS – SOFTWARE

4.1 SYSTEM SOFTWARE

A. System software shall be fully licensed to the owner for all Host computer(s) and laptop(s).

B. System software shall, at a minimum, provide:
1. Monitor and supervise all control points.
2. Add new points and edit system database.
3. Change control setpoints, timing parameters, and loop-tuning of PID coefficients in all control loops in all control units.
4. Enter programmed start/stop schedules.
5. View alarm and messages.
6. Modify existing control logic (or sequence of operation) in all control units.
7. Upload/Download programs, databases, control parameters, etc.
8. Modify graphic screens.

4.2 PRIMARY CONTROL UNIT SOFTWARE

A. Primary controllers shall have as standard feature a complete library of control algorithms for DDC, Energy Management, and Facilities Management functions. Software library shall include as minimum, the following programs:
1. Direct Digital Control Functions
   a) Setpoint Reset
   b) Ramp
   c) Float ON/OFF
   d) 2-position ON/OFF
   e) PID Loop
   f) Self-tuned PID Loop
   g) Linear Sequencer
   h) Rotating Sequencer

i) Binary Sequencer
j) High/Low Select
k) Energy Dead Band
l) Thermostat
m) Interval timer
n) Delay
o) Latch on/off

2. Energy Management Control Functions
   a) Duty Cycle
   b) Temperature Compensated Cycling
   c) Optimum Start/Stop
   d) Electric Demand Limiting
   e) Weekly Scheduling
   f) Calendar and Holiday Scheduling
   g) Enthalpy Changeover
3. Math and Logic Functions
   a) Add
   b) Subtract
   c) Multiply
   d) Divide
   e) Square Root
   f) AND, OR, XOR, NAND, NOR
   g) Invert
   h) Averaging
   i) Summations
   j) Totalization
   k) Event Totalization
   l) Pulse Count Conversion
   m) Time Delay
   n) Curve Fit
   o) BTUH Calculation
4. Facilities Management Functions
   a) Analog High/Low Alarm
   b) Digital Alarm
   c) Trend Log Reporting
   d) Daily EMS Report
   e) Monthly EMS Report
   f) Maintenance Time Reminders
5. HVAC Application Functions
   a) Constant Volume Single Zone
   b) Multizone AHUs
   c) Supply Air Optimization
   d) Hot Deck Optimization
   e) Cold Deck Optimization
   f) Night purge
   g) CO_2 demand control ventilation
   h) Economizer

B. Time Synchronization:
   1. Real-time: The system shall continually adjust the real-time clock at all controllers, panels, and other time-keeping control devices.
   2. Daylight Savings Time (DST): The system shall automatically adjust the real-time clock at all controllers, panels, and other time-keeping control devices for the beginning and end of DST.

C. At no time shall the DDC panel's ability to report alarms be affected by either operator activity at a workstation or local I/O device, or communications with other panels on the network.

4.3 SECONDARY CONTROL UNIT SOFTWARE

A. Secondary control unit software can be a limited version of the software in the primary control unit.

B. Software shall control the equipment as specified in the sequence of operation.

4.4 SCHEDULES

A. Scheduling editor shall be provided at each Host computer

B. Scheduling editor shall include, at a minimum:
1. Easy method for selecting time periods and days for occupied and unoccupied periods for each object (e.g., AHU).
2. Holiday and breaks shall be shown clearly on the calendar
3. Weekly Schedules: The weekly schedules screen shall display a full week with holidays and special days included.
4. Provide a method for allowing several related air handling systems or other equipment to follow a similar schedule.
5. Default schedules shall reside in the local control modules. Master schedules to be in central district.
6. It shall be possible to easily and directly copy the schedule for any scheduled event to any other scheduled event without reentering all times.
7. The scheduling system shall have twice the capacity required for a separate schedule for each major mechanical system (air handler, chiller, boiler, etc.) in the building. Each schedule shall have the capacity for at least 4 on/off events per day, 7 differently scheduled days per week, 20 differently scheduled holidays per year, and 20 differently scheduled “special days” per year.
8. Each schedule shall accept a unique descriptor of up to at least 20 characters to identify the schedule on screen.
9. Annual Schedules: An annual schedule calendar mechanism shall be provided to schedule Holidays and Special days a minimum of one year in advance. A full screen editor in calendar format shall be provided to allow speedy selection and review of holidays and special days.
10. Permanent Schedule Overrides:
    a. It shall be possible to easily override, to the on or off condition, any programmed scheduled event at any operator workstation. There shall be no limit to the number of schedules that can be overridden at any one time.
    b. Each operator override shall remain in effect until removed by an operator or a preset time has expired.
    c. All active overrides shall be registered as non-critical alarms (alarm level 1) at the operator workstation. In addition, a summary (who and when) of all active overrides shall be routed to a designated printer each morning.

4.5 ENERGY MANAGEMENT APPLICATIONS

A. Optimum Start Control:
1. The host software shall provide operator access to Optimum Start parameters for any designated items or equipment or commonly scheduled systems of equipment.
2. Optimum Start programs shall be self-learning and shall adapt the algorithm parameters to the optimum values for each applied zone.
3. Optimum start/stop shall, at a minimum, provide separate control outputs for heating, cooling, fan and ventilation control sub-systems to maximize energy efficiency.

4. Software shall provide adjustable maximum time periods (from 10 minutes to 3 hours) for optimal start.

4.6 TRENDING

A. The system shall be capable of trending any input or output, or any logical point within the program.

B. All trend data shall be able to be shown at the operator workstation in either graphical (line graph) or tabular format. Both formats shall be printable on standard laser or ink jet printers (color, black and white).

C. The interval between trend samples shall be adjustable from 1 second (PID loop verification) to 24 hours using a minimum of 14 different steps (e.g., 1 second, 15 seconds, 1, 2, 5, 10, 15, 20, 30, 60 minutes, and 2, 6, 12, 24 hours).

D. The host software shall support logging and historical accumulation of trended data from the entire facility or multiple sites.

E. Trend data shall be automatically downloaded to the hard drive without causing loss of data.

F. The host software shall provide capacity to store to disk a directory of all trend logs for one year. Such trend logs can be accessed directly by the operator at any time for analysis of selected sets of the trended data, displayed onto the screen, or hard copy documentation.

G. The host software shall enable the operator to simultaneously view X-Y graphic plots of at least eight (8) variables in real-time or historical data. The variables shall be distinguishable by using unique colors and engineering units shall be displayed. The scale for the X- axis and Y-axis shall be user adjustable.

H. Trend graph shall be able to display two (2) Y-axes for convenient viewing. Trends from one or more control units shall be able to be simultaneously displayed on a single trend graph.

I. The host software shall, in addition, provide bar charts of energy usage information, such as charts of daily peak demand, etc.

J. Data shall be seamlessly converted to an electronic format easily read by commercial spreadsheet software (quote and comma separated text) and by ACCESS database program.

PART 5 - SYSTEM SETUP

5.1 RESPONSIBILITIES OF INSTALLER AND PROGRAMMER

A. This section further defines the responsibilities of the installer and programmer.

B. The following features shall be incorporated into the final delivered product.

5.2 PASSWORDS

A. Provide four password levels.
1. Level 1: Full access to change programming code and all variables.
2. Level 2: Access limited to changing any adjustable parameter (e.g., fan status). Level 2 access shall allow the operator to perform the following commands including, but not limited to:

a. Start-up or shutdown selected equipment
b. Adjust setpoints
c. Add/Modify/Delete time programming
d. Enable/Disable process execution
e. Lock/Unlock alarm reporting for each point
f. Enable/Disable Totalization for each point
g. Enable/Disable Trending for each point
h. Enter temporary override schedules
i. Define Holiday Schedules
j. Change time/date
k. Enter/Modify analog alarm limits
l. Enter/Modify analog warning limits

3. Level 3: Access limited to changing room temperature setpoints.
4. Level 4: Access limited to changing Holiday Schedules.
5. Level 5: User is only able to view data on screen.

B. Programmer will not provide owner high clearance passwords until job has been accepted.

5.3 POINTS

A. All points (DI, DO, AI, and AO) will have unique alphanumeric names and addresses. Installer and programmer will determine: scanning frequency (rate), units, scaling factors, high and low alarm values, alarm differentials, default values, and ranges in coordination with engineer and Owner staff.

B. Provide the following minimum programming for each analog input:
1. Name
2. Address
3. Scanning frequency
4. Engineering units
5. Offset calibration and scaling factor for engineering units
6. High and low alarm values and alarm differentials for return to normal condition
7. High and low value reporting limits (reasonableness values) which shall prevent control logic from using shorted or open circuit values.
8. Default value to be used when the actual measured value is not reporting. This is required only for points that are transferred across the primary and/or secondary networks and used in control programs residing in control units other than the one in which the point resides. Events causing the default value to be used shall include failure of the control unit in which the point resides, or failure of any network over which the point value is transferred.
9. Selectable averaging function which shall average the measured value over a user selected number of scans for reporting.

C. Provide the following minimum programming for each analog output:

1. Name
2. Address
3. Output updating frequency
4. Engineering units
5. Offset calibration and scaling factor for engineering units
6. Output Range
7. Default value to be used when the normal controlling value is not reporting.

D. Provide the following minimum programming for each digital input:
1. Name
2. Address

3. Scanning frequency
4. Engineering units (on/off, open/closed, freeze/normal, etc.)
5. Debounce time delay
6. Message and alarm reporting as specified.
7. Reporting of each change of state and memory storage of the time of the last change of state.
8. Totalization of on time (for all motorized equipment status points), and accumulated number of off-to-on transitions.

E. Provide the following minimum programming for each digital output:
1. Name
2. Address
3. Output updating frequency
4. Engineering units (on/off, open/closed, freeze/normal, etc.)
5. Direct or Reverse action selection
6. Minimum on time
7. Minimum off time
8. Status association with a DI and failure alarming (as applicable)
9. Reporting of each change of state and
10. Reporting of memory storage of the time of the last change of state.
11. Totalization of on time (for all motorized equipment status points), and accumulated number of off-to-on transitions.
12. Default value to be used when the normal controlling value is not reporting.

5.4 ALARMS

A. The Control Contractor in coordination with the owner and design engineer shall specify values that trigger alarm conditions.

B. The Control Contractor in coordination with the owner and design engineer shall specify the alarm level that requires on-screen operator acknowledgement.

C. Provide five alarm levels.
1. Level 1 alarm (smoke and/or fire)
2. Level 2 alarm (equipment failure/damage imminent)
3. Level 3 alarm (equipment requires hardware or software reset)
4. Level 4 alarm (equipment requires servicing and/or energy is being wasted)
5. Level 5 alarm (temperature setpoints are out of bounds)

D. Provide five locations for reporting of alarms.

1. Level 1: Send Level 1 alarm to F.A.C.P., to security monitor
2. Level 2: Send Level 2 alarm to central control monitor
3. Level 3: Send Level 3 alarm to central control monitor
4. Level 4: Send Level 4 alarm to maintenance shop monitor and printer
5. Level 5: Send Level 5 alarm to printer only

E. All alarm reports shall include the point's English language description, point address, an alarm message to more fully describe the alarm condition and/or direct operator response, and the time and date of occurrence.

5.5 DATA TRENDING

A. Data trending will be set for the start-up period and after system acceptance.

B. Date trended during system start-up and before system acceptance shall include all real and virtual data points. Data will be collected and stored every one minute unless otherwise noted on blueprints or in appendices.

C. Establish data trended (every 15 minutes) of the following points after system acceptance:
1. Outside Air Temperature
2. Outside Air Enthalpy
3. Occupancy schedule
4. For each air handler
   a) On/Off status
   b) Discharge Air Temperature
   c) Discharge Air Temperature setpoint
   d) Mixed Air Temperature
   e) Mixed Air Temperature setpoint
   f) Return Air Temperature
   g) Return Air Enthalpy
   h) Heating Valve Position
   i) DX status
5. Space Temperatures and temperature setpoints
6. Percent heating and Cooling Load for each zone

D. All data will be saved on the hard drive for at least one year.

5.6 SCHEDULES

A. Schedule will be installed using time parameters provided by owner or obtained on drawings.

5.7 GRAPHIC SCREENS

A. Host Computer Software: Since the primary operating software is resident to the controllers, the primary purpose of the host computer and software is enhanced man-machine interfacing, enhanced reporting, sequence of operating modification, and centralized monitoring and control.

B. Host computers shall be located in location identified by school.

C. Colorgraphic Operator Interface:
1. Each colorgraphic terminal shall be driven by software allowing the operator to access any system information via a system penetration method.
2. System penetration shall allow the operator to begin at an entire site plan colorgraphic display and progressively select portions of the site plan to be chosen for closer inspection or selection of a more detailed colorgraphic display of a desired system without being required to enter any commands via the keyboard. Specifically,
   a. Graphics display screens shall include a system level graphic of either a map of facilities or an elevation of the building, a graphic of each building floor plan and graphics for each operating system or unit within each building. Entry to the zone and equipment level interface graphics shall be through area maps and/or floor plans to facilitate user orientation. Graphics shall be accessed by using a mouse or other pointer device. The system shall provide a visual indication of which building, floor and zone the user is accessing at any time.
   b. Graphics shall be provided all mechanical equipment and devices controlled by the DDC system. These graphics shall include:
      1) Flow diagram or graphic diagram
      2) Current status of all I/O points being controlled and applicable to each piece of equipment.
      3) Operating mode (occupied, unoccupied, warm-up, purge cycle, etc.)
      4) Time and date

5) Percentage valve/damper open or closed. Include “open” or “closed” on the screen next to percentage.
6) Analog readouts in mA or VDC (for commissioning and can be located on a separate screen if needed to reduce screen clutter)
7) All analogue and digital input and output points shall be settable from the screen.
8) Place all values in appropriate engineering units and in appropriate locations on the graphic representation.

c. All colorgraphic screens shall be standardized for similar mechanical equipment and control devices. The type of points will be the same for similar colorgraphic screens.

D. Accessible System Information:
1. Available for display or modification in any specific colorgraphic display shall include, but not be limited to:
a. Real-time value display of any connected point in the system
b. Alarm status condition of any desired system alarm point
c. Any software parameter such as setpoints for control sequences, minimum position adjustments, or throttling ranges

E. Centralized Scheduling and Modification: The colorgraphic terminal shall support operator access to the global Scheduling Screens that allow the operator to review and modify any or all schedules as desired. The centralized Scheduling function shall allow modification of equipment and lighting operating schedules, modification of facility holiday schedules, and when desired allow assignment of temporary schedules for designated portions of the facility or specific equipment.

5.8 ON-SCREEN SENSOR RESOLUTION

Sensor Type	Resolution (displayed on screen)
Temperature	0.1°F
Pressure	0.01 inches w.c.
Actuators (damper and valve)	1% of full range
Humidity	0.5% RH
Air Flow	10 CFM
CO_2 sensors	20 PPM
Current Sensor	0.1 kW

5.9 OVERRIDES

A. All equipment (boilers, air handling units, chillers, etc.) shall have manual overrides in the event of DDC system failure. The DDC system should recognize the override and report an alarm (alarm level 3) to the screen and the printer.

B. The manual overrides for all system shall be in one location as specified by the Engineer.

C. Software shall have adjustable time limits for each override.

D. Provide override switches (see drawings for location of panel for each unit). Each momentary switch with lockout and light (green for “on,” red for “off”) to activate an override of unit(s) as programmed through software. Each override to have adjustable time setting and revert to previous mode of operation at time’s end.

E. See Drawings for building shut-off switch. Switch to shut off all air handling equipment except exhaust fans.

5.10 SAFETY CIRCUITS

A. All safety circuits shall be hard wired circuits with independent manual reset type switches.

5.11 LABELING AND IDENTIFICATION

A. All devices relating to the work or systems included herein, including controllers, valves, motors, relays, etc., shall be identified with a unique identification number or name on the submitted engineering drawings. This identification number or name, along with the service of the device (discharge air controller, mixed air controller, etc.), shall be permanently affixed to the respective device.

B. All field devices will be supplied with a nameplate indicating its name, number, address, and all other pertinent information.

C. If the field device is too small for the nameplate to be "adhered" to or on another piece of equipment near it (e.g., nameplate on air handling unit at wire penetration for mixed air temperature sensor), then attach the nameplate via nylon ties.

D. Tagging shall be computer generated. For input/output wiring, cabling, or tubing, the panel side of the terminals shall be labeled with the automation panel circuit board and terminal numbers associated with the point. The field side shall be labeled with the point number. Cable, wiring and tubing not specifically associated with an input or output shall be labeled with a number and function.

E. All wiring, tubing, and cabling both inside and outside of control panels shall be labeled at both ends using Thomas and Betts EDP printable wire and cable markers using style WSL self-laminating vinyl. Input and output cables and wiring shall be labeled with the point number and the point description, such as:

CPDPS005
Primary Heating Water
Pump #1 On/Off Status

F. Cable and wiring not specifically associated with an input or output shall be labeled with a number and a function description such as:

120 VAC
Panel #

5.12 REPORTS

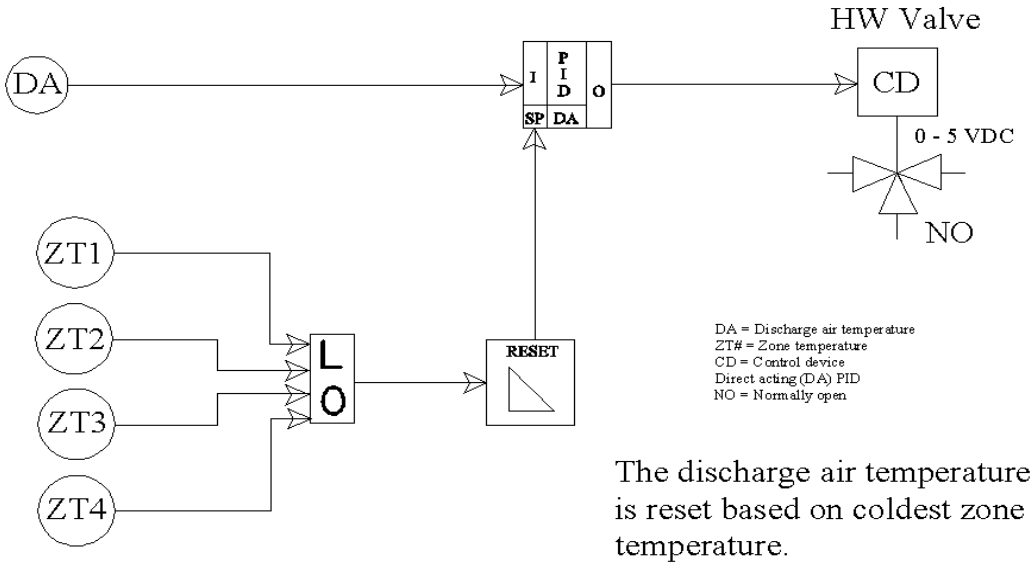
A. At a minimum, the system shall allow the user to easily print the following types of reports.
1. General listing of all points in the network
2. List of user accounts and access levels
3. List of all points currently in alarm
4. List of all off-line points
5. List of all points currently in override status
6. List of all disabled points
7. List of all points currently locked out
8. List of all Weekly Schedules
9. List of all Holiday Programming
10. List of Limits and Deadbands, throttling ranges, gains, etc.
11. List of all adjustable and virtual points

PART 6 - SEQUENCE OF OPERATION

6.1 LEVEL OF DETAIL

A. Major changes in provided sequence of operation must be approved of in writing by the owner and the Engineer.

B. The Control Contractor shall provide two types of documentation for each system (e.g., boiler plant, VAV system, etc.). The two types of documentation include:
   1. Control Logic
      a. Control logic shall be a series of statements providing, for each system, the following items:
         1) Identification of control process
         2) Narrative of control loop or logic algorithm
         3) Control parameters such as setpoints and differentials (e.g., throttling range, gains) reset schedules, and adjustable parameters for all points
         4) Identification of all constraints, limits, or interlocks that apply to control loop
         5) Identification of all DO, DI, AO, AI points that apply to system
         6) Identification of all communication needs (data points from outside control unit)
   2. Logic Diagrams
      a. For each control logic system, a logic diagram shall show the actual interaction of the points (real and virtual) and the logic algorithm.
      b. The diagram should identify
         1) System being controlled (attach abbreviated control logic text)
         2) All DO, DI, AO, AI points
         3) Virtual points
         4) All functions (logic, math, and control) within control loop
         5) Legend for graphical icons or symbols
         6) Definition of variables or point names (e.g., OAT = outside air temperature)
         7) Define values (e.g., 1 = on, 0 = off)
      c. See figure below for example of logic diagram).



6.2 STANDARDIZATION

A. All control loops will be standardized throughout the programming code.

6.3 PROGRAMMING GUIDELINES

A. All adjustable setpoints shall be developed as software points stored at memory locations so that setpoints can be changed by recommanding the data stored at the memory location rather than by entering the program and changing parameters and lines in program code.

B. Where reset schedules are specified or required the schedules shall be set up so that the operator enters the following points into memory locations.
1. Two points for the independent variable on the reset schedule.
2. Two points for the dependent variable on the reset schedule.
The computer system shall then use these values as input parameters to the appropriate program or programs and calculate the reset schedule based on these values.

C. Where several analog outputs are to be controlled in sequence by one control loop, software shall be arranged so that the sequence is guaranteed regardless of the spring range of the actuators and to prevent simultaneous heating and cooling.

D. Programs controlling several pieces of equipment as one system shall reside in one control unit. Where programs use data points that reside in other control units the programs shall employ logic (either in software, firmware, hardware, or a combination of all three) to detect loss of communications with the remote control units containing the required data. When such a failure is detected, the program logic shall revert to a safe operating mode that will allow the controlled systems to remain in operation until normal system communication resumes. A pilot light on the control unit shall be illuminated when such a failure mode exists. In addition, an alarm shall be sent to the HOST computers (alarm level 4). The software shall track this type of alarm and report if communication failure is higher than expected (this condition shall generate an alarm level 3, with descriptive text, at the HOST computer). All safe operating modes shall be approved by the Engineer prior to implementation.

E. Control sequences that use outdoor air conditions to trigger certain specific operating modes shall use data generated by one outdoor air temperature sensor and one outdoor humidity sensor. In other words, the data from one pair of sensors shall be shared by the entire system.

F. All safety circuits shall be hard wired circuits using standard snap acting electric or pneumatic switches as required by the function, and shall be totally independent of the DDC system controllers. This includes interlocks that return dampers and valves to some normal, fail-safe position when the system they are associated with shuts down. It is the intent of this paragraph that the systems have the capability to be operated manually complete with safeties and fail safe interlocks even if the DDC system is off line.

G. Provide hours of operation accumulation and lead/lag sequencing of equipment based on hours of operation for all equipment with proof of operation inputs.

H. Global point name changing:

1. The system shall provide an easy means to allow the operator to change a point name such that the point will automatically be referenced everywhere in the system by the new name.

2. If a point name is removed from the database, any program code where the name appears must show an appropriate error signal for undefined point when the program is viewed, edited, or printed.

I. Synchronization of real-time clocks between all control panels shall be provided.

6.4 GENERAL SEQUENCE OF OPERATION GUIDELINES

A. Control of all central fan systems, boilers, DX units, heaters, and pumping stations shall be based on run requests, heating requests or cooling requests from zone controls.

B. Reset of supply air temperature and hot water temperature shall be based on zone temperature conditions via the zone's percentage of heating or cooling load.

C. Unless otherwise indicated, all control loops will use PID loops. The coefficient for the derivative component is zero (0) unless otherwise indicated.

D. All HVAC system controls shall be designed such that simultaneous heating and cooling, reheating, and recooling are minimized. This applies as well to non-mechanical treatment of mixed air (e.g. outside air, heat recovery, etc.) which must then be mechanically reheated or recooled.

E. Alarms: Except as directed otherwise by the Owner, all alarms will be registered at the building operator's terminal as well as at the Maintenance Building remote operator's station. Alarms are to be registered with a message explaining the nature of the alarm and which building/location the alarm is in.

F. Whenever a setpoint is referred to as "adjustable" in these standards, the setpoint is to be easily and directly adjustable at the operator's terminal and Maintenance Building remote operator's station, and is not to require any code modification. This may require assigning virtual points to all adjustable setpoints. Frequently adjusted points, including space temperature setpoints, shall be adjustable from the graphics screen (e.g., floor plan screen).

G. There are many interlocks and limits within each control loop or algorithm that may not be obvious or stated in this specification. The Control Contractor is responsible for identifying and programming these interlocks and limits into the software. The CO_2 Demand Ventilation Control algorithm is a good example of the complexity of the control loop with interlocks and limits.

H. The Control Contractor will replace any and all equipment (actuators, chillers, etc) that fail due to programming errors. Such errors include, but are not limited too: moving actuators a couple fractions of a degree every second or so in response to some infinitesimal change in a measured variable or repeatedly turning equipment on/off within a short time period. The Control Contractor will avoid these problems by incorporating time delays, dead bands, and other programming techniques into the sequence of operation.

I. Programmable time-of-day (start/stop) control shall be implemented for all HVAC equipment, except for:
1. equipment that is interlocked with other equipment under direct start/stop control (e.g. exhaust fans interlocked with an air handling unit)
2. equipment that must run continuously for reasons of safety
3. as otherwise noted in these standards

J. Auto-tuning algorithms will not be used to initially tune control loops.

6.5 SEQUENCE OF OPERATION GUIDELINES

A. This specification is intended to refine or elaborate on the sequence of operations provided by the Engineer. Note: there are many issues that may make any of these standard sequences inapplicable to a specific situation: thus, the Control Contractor should endeavor to implement or improve the sequence of operations contained in this specification.

B. The Control Contractor shall adhere to all applicable specifications, unless they submit written exceptions to the Owner and Engineer and such exceptions are approved in writing. Written exceptions shall state the specification's sequence of operations, the Control Contractor's proposed sequence of operations, and the reasons why the proposed sequence specifications are preferable to the sequences in this specification or those provided by the Engineer.

C. It is the Control Contractor's responsibility to improve upon these specified sequences of operations if necessary. All improvements will be provided in writing to the Engineer for his/her written approval.

D. All VAV air handling units (AHUs) will use primary control units and will include the following sequence of operations:

1. Supply Fan Control
2. Return / Relief Fan Control
3. Fan Enable / Optimal Start (Warm-Up)
4. Fan Enable / Optimal Start (Cool-Down)
5. Condensing unit staging
6. Heating Section Control
7. Night Purge
8. Night Low Limit
9. Night High Limit
10. Economizers (outside air)
11. Stand-by mode (close outside air dampers during morning warm-up and before major occupancy period)
12. Discharge Air Temperature Reset
13. Humidity Control
14. Zone Control
15. CO_2 Demand Ventilation Control (if specified in drawings)
16. Occupant Override
17. System Safeties
18. Exhaust Fans

E. All Constant Volume air handling units (AHUs) will use primary control units and will include the following sequence of operations:

1. Supply Fan Control
2. Fan Enable / Optimal Start (Warm-Up)
3. Fan Enable / Optimal Start (Cool-Down)
4. Heating Coil (Re-Heat Coil) Valve Control
5. Night purge
6. Night Low Limit
7. Night High Limit if applicable
8. Economizers (outside air)
9. Stand-by Mode (Close outside air dampers during morning warm-up and before major occupancy period)
10. Discharge Air Temperature Reset
11. Zone Control
12. CO^2 Demand Ventilation Control (if specified in drawings)
13. Occupant Override
14. System Safeties

15. Exhaust Fans

F. The Control Contractor is responsible for accurately controlling and communicating with all packaged fan units or air handling units.

G. The heating and cooling plant will include the following sequence of operations:
1. Chilled water cooling system control
   a. Chilled Water Control Logic Overview
   b. Primary Chilled Water Loop
   c. Chiller/BAS Interface
2. Condensing unit compressor staging
3. Heating Water System Control
   a. Heating Control Logic Overview
   b. Primary Hot Water Loop
   c. Boiler
   d. Boiler/BAS Interface

H. Meetings with Engineer and Owner may modify the required list of sequence of operations for individual AHUs and the heating/cooling plant.

6.6 SEQUENCE OF OPERATION

A. AHU – Constant Volume and Single Zone: All setpoints are adjustable. All X% to be determined by the Balancing Agency.

1. General:
   a. Supply and return current switches monitor fan status. If any fan is commanded to operate and its status is not detected within 30 seconds, an alarm is generated at the operator's terminal.
   b. Control contractor supplies the freeze thermostat and it is wired to shut down the unit if it senses temperature below its setpoint. This freeze start has to be reset manually with software or hardware before the unit can operate again.
   c. Smoke detector shuts down the unit if it detects any particle of smoke in the return air. An alarm is generated at the operator's terminal.
   d. Mixed air dampers shall be closed to outside air when supply fan status cannot be detected.
   e. Since this unit is serving one zone only, the VFD will be set manually from the operator's terminal to run at a certain speed once it is enabled.
   f. Occupied Override: Same as VAV system.
2. Unoccupied Mode:
   a. System shall maintain 55 F room temperature during all fan 'Off' periods.
   b. Supply and return fans shall start when any zone temperature falls below night low limit setpoint.
   c. Mixed air dampers are closed to outside air.
3. Warm-up:
   a. Supply and return fans start prior to occupancy to bring the space temperature to occupied setpoint by occupancy time.
   b. Mixed air dampers are closed to outside air.
   c. Heating valve modulates open to raise the space temperature to occupancy setpoint.
   d. Cooling is disabled during warm-up.
4. Occupied Mode:
   a. Supply and return fans run continuously.
   b. Mixed air dampers are open to maintain minimum outside air. The minimum outside air damper position is reset to maintain return air CO2 setpoint.

c. The return and exhaust damper position is calculated by selecting the highest output of the discharge air temperature loop, CO2 loop or the minimum ventilation position, all subject to low limit. (Minimum mixed air temperature is 45 F).
d. Reset discharge air temperature setpoint from space temperature as follows:
1) When room requires full heat, discharge air setpoint will be 104 F.
2) When room requires full cool, discharge air setpoint will be 55 F.
e. Heating Mode Discharge Temperature Control: Heating coil and mixed air dampers modulate in sequence to maintain discharge air setpoint. Mechanical cooling is disabled by resetting cooling setpoint to 90 F.
f. Cooling Mode Discharge Temperature Control: Mixed air dampers modulate to maintain mixed air temperature equal to discharge air setpoint. A mechanical cooling setpoint is sent to air handling unit controller, equal to discharge air setpoint plus 2 F (adjustable). Cooling coil control valve modulated when applicable.
g. When outside air temperatures rises above return air temperature, outside and exhaust air dampers close to minimum position and return air damper opens to maximum position.

B. Fire/Smoke Dampers: The following is stipulated for all fire/smoke dampers.
1. All fire smoke dampers shall go closed when the air handler is shut down.
2. All fire smoke dampers shall be fitted with an end switch which shall identify its condition to the building management systems. This shall be done through the closest VAV box. Each fire smoke damper shall be individually addressable.
3. The fire smoke dampers shall be opened with either an auxiliary contact on the supply fan VFD or a software command.
4. A Lonworks Lon Card is the desired interface.

C. Domestic Water Recirculation Pump:
1. The domestic water recirculation pump shall be controlled by the building management system. Recirculation pump shall operate during occupied hours.
2. Control points shall be pump start/stop, pump status, return water temperature.

D. Variable Air Volume Control: All adjustable setpoints are shown in brackets with an initial setpoint value. Commissioner will determine final setpoint values.
1. Supply Fan Control:
a. The supply and return air fans operate during the preheat, precool or occupied modes as determined by the optimal start sequence.
b. They operate subject to the smoke detector.
c. They operate subject to the freeze stat (manual reset required).
d. The smoke is hardwired to the fan starters such that fans are disabled both in hand and auto positions.
e. The freeze stat is hardwired to the fan starters such that fans are disabled both in hand and auto positions.
f. Duct Static Pressure Control:
1) When fan status is detected, the supply fan VFD is ramped up slowly to allow the control loop to smoothly gain control.
2) The static sensor will be located 2/3 down the duct. When fan status is detected, the supply fan VFD is modulated to maintain the duct static pressure setpoint.
3) The VAV box that is calling for the greatest percentage of its maximum CFM setpoint will be selected. The duct static pressure setpoint will be reset between .75” WC and 1.25” WC to maintain this value to 90%. Once the minimum discharge setpoint is achieved, static pressure reset is achieved.
4) The supply fan VFD control is subject to a high static pressure switch (manual software or hardware reset required) located in the discharge duct

and before any smoke dampers. This switch will be hard wired to shut down the supply and return VFD and provide software input to the BAS.

5) An alarm will be generated when the high static pressure switch trips.

g. Fan speed is reset to zero Hz when the supply fan status is off.

h. Variable speed drive acceleration settings, deceleration settings, minimum speeds, etc. are adjusted at start up in coordination with the drive supplier and installer to achieve stable control system performance.

2. Return Fan Control:

a. Upon return fan status transitioning to on, the VFD and building static pressure control is enabled.

b. Building Static Pressure Control:

1) Each AHU will use the average of all the space static sensors for its return fan control.

2) When the building static is at setpoint 0.05” WC, the return fan VFD speed is the same as the supply fan.

3) As the building static increases above setpoint, the return fan VFD speed is biased above the supply VFD speed, up to 20%, until building is at static setpoint.

4) As the building static decreases below setpoint, the return fan VFD speed is biased above the supply VFD speed, up to 20%, until building is at static setpoint.

5) Fan speed is reset to zero Hz when the return fan status is off.

6) Variable speed drive acceleration settings, deceleration settings, minimum speeds, etc. are adjusted at start up in coordination with the drive supplier and installer to achieve stable control system performance.

3. Optimal Start:

a. The intent of this sequence is that the air handling system be started early enough that the average space temperature is at the target temperature setpoints of 70 F for preheat and 73 F for precool, at the scheduled occupancy time.

b. The optimal start sequence may start the air handling systems prior to occupancy no more than the maximum start time limit setpoint. (3 hours)

c. The optimal start sequence uses the average space temperature, area characteristics and mechanical equipment capacity and outside air temperature to calculate a lead-time in advance of scheduled occupancy time.

d. The actual area response is analyzed and weighted adjustments are made to the calculation.

e. The optimal start sequence will determine the prestart mode, preheat or precool, based upon the average space temperature and the occupied or unoccupied mode, based upon the occupancy schedule.

f. The optimal start sequence will not enter in to the precool mode unless the outside air temperature is below 55 F.

g. The optimal start sequence mode can be overridden for each individual air handling system or globally for all air handling systems in the building.

4. Occupant Override:

a. When key operated lockout switch is in ‘on’ position, override panel is activated and air-handling units can be overridden.

b. The systems override panel located in the custodian room has override push buttons for AHU-1, 2, 3 and 4. When the push button is pushed, the respective air-handling unit is activated into the occupied mode for 60 minutes (adjustable with software).

c. Panel lights indicate fan status for all units. The fan status panel light is on solid when fan is running. The fan status panel light blinks when fan is running due to activation form the override panel.

d. At the end of any override period, the system reverts to the scheduled mode in effect.

5. CO2 Demand Ventilation Control (CO2 DVC):

a. The operator shall have the on-screen ability to override the CO_2 DVC and return the system to normal occupancy operating mode. This override shall send a level 3 alarm and indicate the override on screen until the override is disabled.
b. BAS shall normally execute the thermal PID algorithms to maintain thermal comfort settings as determined by space temperature sensor and control parameters.
c. BAS shall use available internal proportional, integral and derivative algorithms to modulate the outside air dampers on the AHUs to maintain space CO_2 levels under a pre-determined level for active CO_2 DCV.
d. In anticipation of a large crowd, a manual override can pre-ventilate the space. The manual overridden shall execute a control routine to proportionally increment outside air dampers open up to the minimum outside air design (determined by maximum space occupancy), over a set time period (determined by the Engineer) that complies with lag times permitted by ASHRAE 62-1989. Proportional opening of the dampers over a period of time will also ensure adequate temperature control within the space.
e. If the BAS's economizer algorithms determine that the AHUs should have a greater percent of outside air than determined by the CO_2 DCV algorithm, then the economizer algorithms shall supersede CO_2 DCV algorithms and determine outside air damper position. The CO_2 DCV purge algorithms shall, however, supersede the economizer algorithms if CO_2 levels exceed 1,000 PPM.
f. Occupied Mode (low occupancy).
    1) During periods when occupancy loads are less than design occupancy loads, the outside air flow requirements can be decreased below design flow rates. A minimum rate, however, must be maintained in order to remove CO_2 and other contaminants during low occupancy periods. Outside air dampers will be opened to a minimum ventilation position as defined by carbon dioxide control sequence permitted under ASHRAE Interpretation IC 62-1989-27 of ANSI/ASHRAE 62-1989. Outside air dampers shall be positioned to achieve a desired damper setting of approximately 25% of the original minimum outside air design (which is equal to 15 CFM per person times the design occupant capacity).
    2) Minimum AHU outside air flow rate shall be as listed on plans.
    3) When space occupancy levels require more ventilation to ensure acceptable CO_2 concentration levels, ventilation rates shall be adjusted as follows:
        a) Return air CO_2 level shall be maintained to assure maximum overall space CO_2 levels equal to or less than 600 PPM (Parts Per Million), adjustable, above background outside air CO_2 levels as indicated by the outside air CO_2 sensor (or by operator input). This strategy should achieve an upper control loop setting of approximately 1,000 PPM (the CO_2 level for a target ventilation of 15 CFM per person at 400 PPM nominal outside air CO_2) within the space. The BAS shall override outside air damper control loop setting proportionally up to a maximum damper setting equal to but no greater than the design minimum outside air damper position. Economizer may override outside air damper position if required for free cooling.
4) Cooling Mode Discharge Temperature Control: Mixed air dampers modulate to maintain mixed air temperature equal to discharge air setpoint. A mechanical cooling setpoint is sent to air handling unit controller, equal to discharge air setpoint plus 2 F (adjustable). Cooling coil control valve is modulated.g.
Occupied Purge Mode (CO_2 levels above upper control setpoint).
    1) Upon sensing a rise in space CO_2 levels above 1000 PPM as indicated from the CO_2 sensor, the CO_2 DCV algorithm shall override the thermal comfort algorithms to reduce CO_2 levels in the space(s) by proportionally modulating (up to 100 percent open if necessary) the outside air damper to maintain space CO_2 level below 260 PPM above current outside air CO_2 reading, or approximately an upper control setpoint of 1000 PPM.

2) When the CO_2 DCV algorithm is activated to purge the space, thermal comfort shall be maintained to ± 3°F (adjustable) of the space sensor's original temperature setpoint as a deadband. If CO_2 DCV purge exceeds the thermal comfort deadband of ± 3°F for more than 15 (fifteen) minutes, then the BAS shall release the CO_2 DCV override and return control to thermal comfort control. Changes made in the space temperature setpoint during a purge sequence shall be ignored for the purposes of DCV control. If the space CO_2 levels are not reduced to less than 150 PPM below the upper control setpoint of approximately 1000 PPM within 15 minutes after being overridden and the space temperature has stabilized, then the DDC system shall continue the purge mode until such time as the space CO_2 levels has been reduced or the thermal comfort parameters are exceeded.
3) If the CO_2 DCV control override successfully purges the space without exceeding the thermal deadband comfort range setting of ± 3°F and CO_2 levels are 150 PPM below the upper control setpoint, the DDC controller shall return control to the thermal comfort algorithms and non-purge CO_2 DCV mode.
4) The CO_2 DCV will be overridden by the unoccupied mode control algorithms even if CO_2 levels are above 1000 PPM when the unoccupied period is initiated.

h. Unoccupied Mode:
1) The CO_2 DCV will not operated during the unoccupied mode unless the manual override has been activated. During the manual override of the unoccupied control mode, the CO_2 DCV will operated as described above.
2) The CO_2 DCV shall not operate during the optimal start algorithm. Outside air dampers will remain closed.
3) During an optimal stop algorithm, the CO_2 DCV shall operate to control CO_2 levels as described above.

6. Modes of Operation:
a. Off (Unoccupied): Initiated by optimal start sequence or fan status of off.
1) Supply and return fans are off.
2) Outside and exhaust air dampers are closed and return damper is open.
3) Heating water valve is open, cooling valve closed.
4) Heating coil pump is off. (On if outside air temperature is below 35 F.)
5) Associated exhaust fan is off.

b. Preheat: Initiated by optimal start sequence or night low limit (55 F).
1) Supply and return fans are on.
2) Outside and exhaust air dampers are closed and return damper is open.
3) Heating water valve modulates to maintain discharge air preheat setpoint (90 F, adjustable).
4) Heating coil pump is on if heating valve is open greater than 10% for 3 minutes. (Heating coil pump is off if heating valve is closed for 3 minutes.)
5) Associated exhaust fan is off.
6) VAV boxes will operate in reverse mode, increasing CFM setpoint as space temperature drops below zone temperature setpoint.

c. Precool: Initiated by optimal start sequence or night high limit (85 F).
1) Supply and return fans are on.
2) Outside and exhaust air dampers modulate to maintain discharge air precool setpoint (55 F, adjustable).
3) Heating water valve is closed.
4) Heating coil pump is off.
5) Associated exhaust fan is on.

d. Auto (Occupied): Initiated by optimal start sequence, occupant override or supply fan status of on during occupied mode.
1) Supply and return fans are on.

a) The mixed air dampers cooling valve and heating valve modulate to maintain discharge air reset setpoint. The VAV box or AHU that is calling for the greatest percentage of cooling will be selected. The discharge air setpoint will be reset between 55 F and 65 F to maintain this valve at 90% volume. This has priority over duct static pressure.
b) The return and exhaust damper position is calculated by selecting the highest output of the discharge air temperature loop, CO2 loop or the minimum ventilation position, all subject to low limit. (Minimum mixed temperature is 45º F.)
c) The outside air damper position is calculated by selecting the highest output of the discharge air temperature loop, CO2 loop, the minimum ventilation position or reset value calculated from the supply fan VFD speed.
d) The VFD reset value is '0' from the supply fan VFD speed is at minimum (determined by balancer) and 100% when the VFD output is at a maximum (determined by balancer).

2) Heating coil pump is on if heating valve is open greater than 10% for 3 minutes. (Heating coil pump is off if heating valve is closed for 3 minutes.)
3) Associated exhaust fan is on, subject to AHU supply fan status.
4) If the outside air temperature is greater than the return air temperature then the mixed air dampers are returned to the minimum ventilation position.
5) If the outside air temperature is less than the low limit setpoint (45 F) then the mixed air dampers are returned to the minimum ventilation position.

e. Zone Control:
1) VAV: Separate heating and cooling setpoints.
a) As the space temperature increases above cooling setpoint (75 F), CFM is reset from minimum CFM setpoint (VAV schedule) to the maximum CFM setpoint (VAV schedule).
b) When space temperature is below heating setpoint (68 F), CFM is at the minimum CFM setpoint.
c) As the space temperature decreases below the heating setpoint the heating valve is modulated to maintain heating setpoint.
d) When AHU system is in the preheat mode the CFM reset will operate in reverse mode. CFM setpoint will decrease as space temperature increases.
e) All VAV boxes with reheat shall have discharge air temperature sensor that is monitored by the BAS.
f) Zone CO2 control: Where CO2 sensors are shown for a zone, the airflow to zone shall be increased incrementally as necessary to satisfy the setpoint of the CO2 sensor. Reheat shall be used to keep the zone from over cooling.

2) Heating water recirculation pump.
a) Pumps shall start on call for heat from respective coils.

f. Freeze: Initiated by freeze stat (set at 35 F, requires manual reset).
1) Supply and return fans are off.
2) Outside and exhaust air dampers are closed and return damper is open.
3) Heating water valve is open.
4) Heating coil pump is on.

g. Fire: Initiated by the affected associated unit or a global building fire alarm.
1) Supply and return fans are off.
2) Outside and exhaust air dampers are closed and return damper is open.
3) Heating water valve is open.
4) Heating coil pump is on.
5) Associated exhaust fan is off and its damper is closed.
6) The smoke dampers are closed.

7) Released to normal after a (upon restoration of alarm to normal, the smoke dampers are opened and fan control is 30 seconds) delay period.

7. Exhaust Fans: In conjunction with respective fans.

E. Boiler Control:
1. Equipment Description: There are two primary pumps equipped. Each pump has been sized to carry the full load of the school's heating water flow requirements.
2. Boiler Sequence of Operations:
a. The primary pumps and boilers run in a lead/lag scenario.
b. The primary pump lead/lag assignment is rotated Monday morning at 8:00 am.
c. If the lead pump fails, the lag assumes the lead position.
d. If the lead boiler fails, the lag assumes the lead position.
e. For the purposes of this sequence, if the air handling system is off all associated heating valve positions are treated as 0% open.
f. When any of the heating coil valves are 15% open and the outside air temperature is less than 65 F, the heating plant is enabled.
g. When any of the air handling systems is in the freeze mode, the heating plant is enabled.
h. When the outside air temperature is less than 35 F, the lead heating water pump is started.
i. When the heating plant is enabled, the lead heating water pump is started.
j. The minimum run time for the pumps after being started is 10 minutes.
k. Upon lead heating water pump status transitioning to on, the lead boiler is enabled.
l. The minimum run time for the boilers after being enabled is 20 minutes.
m. The VAV box or AHU that is calling for the greatest percentage of heat will be selected. The heating water supply setpoint will be reset between 100 F and 140 F to maintain this valve at 90%.
n. When all of the heating coil valves are 0% open for 10 minutes and the outside air temperature is greater than 70 F the heating plant is disabled.
o. When the heating plant is disabled, the lead boiler is disabled.
p. 10 minutes after the lead boiler is disabled, the lead heating water pump is stopped.
q. Each boiler has a two position valve which will open on call for heat from that boiler and close when there is no call for heat from that boiler with a 5 minute (adjustable) delay.

F. Chiller Control:
1. Shall be enabled above 60º F, adjustable.
2. When any of the cooling valves are 15% open and outside air temperature is greater than 60 F the cooling plant is enabled. The initial chiller water temperature shall be 60º F, reset as necessary by the cooling mode discharge temperature controller.
3. Safeties:
a. Chiller shall be started only after water flow is proven with pressure differential switch.
b. Chilled water pump and chiller shall have a minimum run time of 15 minutes. Pump shall remain running as required by manufacturer.
4. Interface chiller for data and control through Ion card.

6.7 MAKEUP UNIT

A. Kitchen:
1. Sequence of Operation:
a. Packaged heating unit with gas heat system to be enabled and disabled by DDC BAS time signal.

b. On a signal to enable unit to operate under package controls (operate fans, heating, glycol chilled water cooling coil and ventilation) based on space sensor signal.
c. Fan status, space temperature, and discharge air temp to be reported to DDC system for remote monitoring and adjustment.
d. Space temperature to be set at 72 degrees F heating (adjustable) and 75 degrees F cooling (adjustable). In occupied mode, outside air damper to open to 10% (when grease hood fan is off).
e. On start of kitchen grease exhaust fan (dishwasher exhaust fan also interlocked) shall go to 100% outside air.
f. Outside air damper is closed with unit off or night low limit.
g. OFF hour operations. Provide labeled bypass switch for make up unit to operate in occupied mode as described in paragraph “d” above. Provide labeled bypass switch for the exhaust fans which will also put the make up unit into 100% outside air. If make up unit is not on when exhaust fans are turned on, then it shall be turned on and set for 100% outside air.

B. Override Switch: Momentary switch to signal software override from current status to occupied. Software point to have adjusted time setting for override.

6.8 DUCTLESS SPLIT COOLING UNIT

A. This unit shall operate continuously subject to its own controls.

B. Building management system shall monitor space temperature and alarm if out of tolerance.

6.9 FCU1 AND FCU-2

A. Same as constant volume except two position outside air damper and no cooling for FCU-1

6.10 DIAGNOSTICS

A. In addition to the standard alarm limits specified for all sensed points, BAS shall provide the following diagnostics for each AHU and VAV terminal box.

B. While heating valve is closed, if the temperature increase across the heating coil exceeds 2°F continuously for 30 minutes, or the discharge air temperature is more than 5°F above setpoint for more than 30 minutes continuously, then send the following level 4 alarm:

“Energy waste: An unexpected temperature rise is occurring across the heating coil at *(AHU/zone name)*. Please check for leaking valve or faulty controls”

C. While cooling valve is closed, if the temperature decrease across the cooling coil exceeds 2°F continuously for 30 minutes, or the discharge air temperature is more than 5°F below setpoint for more than 30 minutes continuously, then send the following level 4 alarm:

“Energy waste: An unexpected temperature drop is occurring across the cooling coil at (AHU/zone name). Please check for leaking valve or faulty controls”

D. A level 4 alarm message should be sent if: The mixed air temperature is less than 55°F or greater than 80°F

Level 4 alarm message is “Energy waste: An unexpected mixed air temperature at (AHU). indicates a possible problem with the economizer damper controls. Please check for faulty dampers or controls”

E. A level 4 alarm message should be sent if: The mixed air temperature, discharge air temperature, and the outside air temperature are not equal when the system is operating at 100% outside air and the heating and cooling valve coils have been fully closed for at least two hours (adjustable). Note: Include in comparison the temperature difference caused by fan energy as it relates to discharge air temperature. If differential between sensors is greater than 0.3°F, then send alarm.

Level 4 alarm message is “Mixed air temperature, discharge air temperature, and the outside air temperature are out of calibration at (AHU).”

F. A level 4 alarm message should be sent if: Any equipment operates for 24 consecutive hours.

Level 4 alarm message is “The ____ has operated 24 consecutive hours. Check software and manual overrides.”

G. A level 4 alarm message should be sent if: Any VFD controlled motor operates at full speed for 24 consecutive hours.

Level 4 alarm message is “The ____ motor has operated 24 consecutive hours at full speed. Check software and manual overrides.”

H. A level 4 alarm message should be sent if: The temperature difference between the refrigerant supply and return is greater than 8°F (set value using manufacturer documentation).

I. Level 4 alarm message is “The refrigerant charge should be check to help avoid compressor failure or lost efficiency.”

6.11 MISCELLANEOUS

A. Domestic Hot Water Recirculation Pump: Enable/Disable pump control from BAS time signal. Pump to operate based on aqua-stat. Locked in return line (just prior to tank).

PART 7 - SYSTEM COMMISSIONING AND TRAINING

Air and water balancing shall be completed (and discrepancies resolved) before Control Contractor’s final system check and before the acceptance test to be conducted in the presence of the Engineer.

7.1 CONTROL TECHNICIAN MEETING REQUIREMENTS

A. During all pre-installation meetings with Owner/Engineers and separate meetings pertaining to the commissioning process, the control technician attending the meetings must be the same technicians that are/will install and program the DDC system.

B. The Control Contractor’s installer and programmer must attend all the commissioning meetings. These meetings occur throughout the design and construction process.

C. First Meeting - discuss point naming and sequence of operation with Engineer and Owner
1. Prior to software and database installation and checkout but subsequent to software and database development, the Control Contractor shall meet with the Owner and the Engineer and review the database and program code in detail on a point by point, sequence by sequence basis. The Control Contractor (using blueprints and this specification) shall provide the project point list and sequence of operation to initiate discussion.
2. Any necessary modifications required to make the database and sequence match the intent and requirements of the contract documents shall be identified at this meeting

including point names, descriptors, alarm setpoint, numeric setpoint requirements, access requirements, sequence adjustments, etc.

3. Successful completion of this review process will result in software and database approval for installation and start-up. Any software or database that is installed prior to this approval process shall be corrected to match the results of the approval process at no additional cost to the Owner.
4. The results of this meeting shall be documented in meeting minutes taken and issued by the Control Contractor. Documentation can be in the form of marked up data base forms and sequences of operation.

D. Second Meeting - graphic screen development shall be coordinated with the Owner through a series of meetings that will allow the functions described above (sequence of operation, alarms, etc.) and any other Owner's requirements to be incorporated into the graphic screens.

7.2 PRE-COMMISSIONING TESTING, ADJUSTING, AND CALIBRATION REQUIREMENTS

A. Prior to acceptance, the following steps will be used by the Control Contractor to produce a testing and pre-commissioning report by system to be submitted for approval by the Engineer or Owner.

B. Work and/or systems installed under this section shall be fully functioning prior to Demonstration, Acceptance Period and Contract Close Out. Control Contractor shall start, test, adjust, and calibrate all work and/or systems under this contract, as described below:

1. Verify proper electrical voltages and amperages, and verify all circuits are free from grounds or faults.
2. Verify integrity/safety of all electrical connections.
3. Verify proper interface with fire alarm system.
4. Coordinate with TAB subcontractor to obtain control settings that are determined from balancing procedures. Record the following control settings as obtained from TAB contractor (and note any TAB deficiencies):
    a. Minimum outside air damper settings for air handling units and CFM values.
5. Test, calibrate, and set all digital and analog sensing, and actuating devices.
    a. Calibrate each instrumentation device by making a comparison between the DDC display and the reading at the device, using a standard traceable to the National Bureau of Standards, which shall be at least twice as accurate as the device to be calibrated (e.g., if field device is +/-0.5% accurate, test equipment shall be +/-0.25% accurate over same range). Record the measured value and displayed value for each device in the Pre-Commissioning Report.
    b. All analog input points are to be tested by comparing the reading obtained through the workstation and through an independent reading device (meter).
    c. Check each analogue output by making a comparison between the control command at the DDC controller and the status of the controlled device. Check each output point by making a comparison of the state of the sensing device and the Host computer display. Record the results for each device in the Pre-Commissioning Report.
        1) All analog output points are to be tested using a command from the workstation modulating the output in 10% increments and recording the associated voltage/amps sent to the controlled device.
6. Check each digital input/output point by making a comparison between the control command at the DDC controller and the status of the controlled device. Check each digital point by making a comparison of the state of the sensing/control device and the Host computer display. Record the results for each device in the Pre-Commissioning Report.
    a. ON/OFF commands from the workstation should be performed in order to verify its true operation.

7. Check and set zero and span adjustments for all actuating devices. Manually activate damper and valve operators to verify free travel and fail condition. Check valve or damper to insure that it shuts off tight when the appropriate signal is applied to the operator. Adjust the operator spring compression as required. If positioner or volume booster is installed on the operator, calibrate per manufacturer's procedure to achieve spring range indicated. Check split range positioner to verify proper operation. Record settings for each device in the Pre-Commissioning Report.
8. Verify proper sequences of operation. Record results and submit with Pre-Commissioning Report. Verify proper sequence and operation of all specified functions by adjusting input variable to determine if sequence of operation is operating as specified.
9. Tune all control loops to obtain the fastest stable response without hunting, offset or overshoot. Record tuning parameters and response test results for each control loop in the Pre-Commissioning Report. Except from a startup, maximum allowable variance from set point for controlled variables shall be as follows:
   a. Air temperature: ± 0.5 degrees F
   b. Water temperature: ± 1 degrees F
   c. Duct pressure: ± 0.05 inches wc

C. Pre-Commissioning Testing, Adjusting, and Calibration shall be completed prior to Substantial Completion.

D. Provide Pre-Commissioning Test Report for approval by the Engineer and Owner before system demonstration.

7.3 DEMONSTRATION

A. Prior to acceptance, the control system shall undergo a series of performance tests to verify operation and compliance with this specification. These tests shall occur after the Control Contractor has completed the installation, started up the system, and performed its own tests (outlined in 7.02 and to be submitted in writing).

B. The tests described in this section are to be performed in addition to the tests that the Control Contractor performs as a necessary part of the installation, startup, and debugging process. The Owner's representative will be present to observe and review these tests. The Owner shall be notified at least 10 days in advance of the start of the testing procedures.

C. Demonstration shall not be scheduled until all hardware and software submittals, and the Pre-Commissioning Test Report are approved by the Engineer.

D. Verifying compliance of equipment operation and sequence of operation with this specification through all modes of operation.
1. If more than 10 percent of the demonstrated equipment operation and sequence of operation fails to operate per the submittals, the demonstration test will be rescheduled after the control contractor takes corrective action.
2. If the Control Contractor fails to demonstrate proper equipment operation and sequence of operation in the second round of tests, the Owner's representative's costs for witnessing all further demonstration may be assigned to the Control Contractor by the Owner as a deduct to their contracted price. Note: The Control Contractor will not be responsible for costs related to poor design or to other factors beyond their control, though it is expected to call any design concerns and other factors beyond their control that might cause system failure to the attention of the Engineer and the Owner.

E. Programming changes for correction of improperly programmed sequences will not be considered legitimate reasons for change orders.

F. Demonstration/Commissioning Software:
   1. Provide fully licensed copy of the required BAS workstation graphic software to be used by the Engineer on a remote computer (not included in contract) for accessing the BAS network via modem. This software copy shall be used only for the purpose of commissioning this project. The Owner agrees that the commissioning BAS software license shall become null and void upon termination of the Contract Warranty Period. The software shall be returned to the Control Contractor within one year after system acceptance.
   2. Software shall be fully configured to view project specific database and shall include trend logs, specified graphic screens, alarms, and reports.
   3. Provide assistance by telephone upon request if required to assist Engineer in setting up software on Engineer ‘s remote computer.
   4. Submit one complete set of programming and operating manuals for all graphics software packages concurrently with the commissioning software. This set will be returned to the Control Contractor within one year after system acceptance.

G. The Control Contractor shall provide at least two persons equipped with two-way communication, and shall demonstrate actual field operation of each controlled and sensing point for all modes of operation including day, night, occupied, unoccupied, fire/smoke alarm, seasonal changeover, and power failure modes. The purpose is to demonstrate the calibration, response, and action of every point and system. Any test equipment required to prove the proper operation shall be provided by and operated by the Control Contractor.

H. As each control input and output is checked, a log shall be completed showing the date, technician's and Engineer’s initials, and any corrective action taken or needed.

I. The system shall be demonstrated following the same procedures used in Pre-Commissioning (Section 7.2)

J. Demonstrate that all points specified and shown can be interrogated and/or commanded (as applicable) from all workstations.

K. At a minimum, demonstrate correct calibration of input/output devices using the same methods specified for the pre-commissioning tests. A maximum of [10] percent of I/O points shall be selected at random by Engineer for demonstration. Upon failure of any device to meet the specified accuracy, an additional [10] percent of I/O points shall be selected at random by Engineer for demonstration. This process shall be repeated until 100 percent of randomly selected I/O points have been demonstrated to meet specified accuracy.

L. The Contractor shall demonstrate that the panels' response to LAN communication failures meet the requirements of these Specifications.

M. Demonstrate that required trend graphs and trend logs are set up per the requirements. Provide a sample of the data archive. Indicate the file names and locations.

N. Demonstrate successful communication of point values between the BAS and other HVAC equipment (e.g., rooftop unit).

O. Demonstrate complete operation of Operator Interface such as graphic screens, trend logs, alarms, etc.

P. Additionally, the following items shall be demonstrated:
   1. DDC Loop Response. The Control Contractor shall supply trend data output in a graphical form showing the step response of each DDC loop. The test shall show the loop's response to a change in set point that represents a change of actuator position of at least 25% of its full range. The sampling rate of the trend shall be from 1 second to 3

minutes, depending on the speed of the loop. The trend data shall show for each sample the set point, actuator position, and controlled variable values (e.g., VFD frequency or Amperage). Any loop that yields unreasonably under-damped or over-damped control shall require further tuning by the Control Contractor.

2. Optimum Start/Stop. The Control Contractor shall supply a trend data output showing the capability of the algorithm. The 5 minute trends shall include the operating status of all optimally started and stopped equipment, as well as temperature sensor inputs of affected areas.
3. Operational logs for each system that indicate all set points, operating points, valve positions, mode, and equipment status shall be submitted to the Engineer. These logs shall cover three 48-hour periods and have a sample frequency of not more than 10 minutes. The logs shall be provided in both printed and disk formats.
4. The DDC and HVAC systems will be shut down for 15 minutes and then re-started. Within 15 minutes, the DDC system shall start and obtain stable control of the HVAC systems without safety trips, alarms, or excessive deviations in temperature and pressure (as defined by the Engineer).

Q. Any tests that fail to demonstrate the operation of the system shall be repeated at a later date. The Control Contractor shall be responsible for any necessary repairs or revisions to the hardware or software to successfully complete all tests.

R. System acceptance shall occur within 120 days of substantial completion. Any delay beyond this period of time shall initiate liquidated dampers unless waived by owner. Failure or delays on engineers / owners part shall not be included in 120 day count.

7.4 ACCEPTANCE

A. All tests described in this specification shall have been performed to the satisfaction of the Owner prior to the acceptance of the control system as meeting the requirements of this document.

B. The system shall not be accepted until all forms and checklists completed as part of the demonstration are submitted and approved.

C. The warranty period starts when the engineering accepts the system and provides this acceptance in written from the Owner and the Control Contractor.

D. Any tests that cannot be performed due to circumstances beyond the control of the Control Contractor may be exempt from the Completion requirements if stated as such in writing by the Engineer. The Owner shall then perform such tests no later than 3 months after the building is occupied. The costs for these additional tests will be incurred by the Control Contractor.

7.5 SPARE PARTS

A. The Control Contractor shall provide two spare fuses of the correct size and capacity for each fuseholder located in all the installed control systems and the Control Contractor’s related equipment.

B. The Control Contractor shall provide two spare pilot lights for each control unit that contains one or more pilot lights.

7.6 OPPOSITE SEASON TESTING

A. Allow for 32 hours of technician’s time to monitor, trend, and adjust the control system during the warranty period to fine tune the various control loops to ensure the system is operating

during other seasons. This time excludes the time normally required to address warranty issues.

B. Control loops shall be tuned for stability and minimum error under all load conditions and all system operating conditions.

7.7 TRAINING

A. Provide a minimum of four separate 4-hour on-site training sessions after system acceptance and at the owner's request. The initial training session will occur after the as-built drawings and submittals have been provided and the Engineer has accepted the system. The other training sessions will occur up to 12 months after the first training session and at the owner's request.

B. Training shall be a mix of classroom instruction, test exercises, and actual keyboard entry and screen viewing at the operator's terminal. Hands-on experience and problem solving shall be emphasized.

C. If during any training session, the trainer debugs more than two (2) items, the training session will be immediately terminated. The session will be rescheduled for another date. The re-scheduled training session will be carried out for the full four hours at no additional cost to the Owner.

D. The first training shall be oriented to making the owner self sufficient in the day to day use and operation of the DDC system. Additionally, the training shall include:
1. System start-up, shutdowns, power outage and restart routines, alarms, security levels, changing setpoints, changing schedules and other parameters, overrides, freeze protection, manual operation, return to automatic operation, and resetting equipment.
2. All screens shall be discussed (allow time for questions).
3. Information specifically focused on showing the owner methods of troubleshooting the mechanical systems using the BAS.
4. Use of laptop and hand-held operator interface device.
5. Creating, modifying, viewing, downloading, and reloading, trend logs. School District staff shall set up at least six trends during training.
6. Remote access to the system via Web, network, and/or phone lines.

E. The other training sessions shall be oriented toward answering specific questions from School District staff.

F. The trainer must be well grounded in both DDC system operation and in mechanical systems service and should be the programmer.

7.8 SPECIAL AS-BUILT REQUIREMENT

A. Contractor shall list airflow calibration numbers for all VAV boxes.

END OF SECTION

PART 1 - GENERAL

1.1 DESCRIPTION

A. Work Included: After completion of the work of installation, test and regulate all components of the new heating, air conditioning and ventilating systems to verify air volumes and heating-cooling flow rates indicated on the Drawings.

B. Balancing Organization:

1. Balancing of the Heating and Air Conditioning Systems: Performed by a firm providing this service established in the State of Oregon.
2. Balancing Organization: Air Balance Specialties, Northwest Engineering Services, Neudorfer Engineers and Pacific Coast Air Balancing, or approved substitute.
3. Provide all necessary personnel, equipment, and services.

1.2 QUALITY ASSURANCE

A. Balancing of the Heating and Air Conditioning Systems: Agency shall be a current member of NEBB or AABC specializing in the adjusting and balancing of systems specified with a minimum of 10 years documented experience.

B. Testing, adjusting, and balancing shall be performed under direct field supervision of a Certified NEBB Supervisor or a Certified AABC Supervisor.

1.3 SUBMITTALS

A. Balancing Data: Include the following minimum information in the Operation and Maintenance Data, as specified in Section 15050.

1. Names or initials of personnel performing the balancing.
2. Dates balancing was performed.
3. List of balancing instruments utilized.
4. Weather conditions at the time of the test.
5. Mechanical system descriptions.
6. All motor rated voltages, amps, starter and overload protective device sizes.
7. All motor operating data.
8. Fan cfm, rpm, operating static pressures, driven and motor sheave data, and all drive changes necessitated to obtain design capacities. List actual minimum outside air volumes measured for each system.
9. All supply, return and exhaust air outlet cfm readings.
10. Terminal unit cfm and static pressures on full cooling and heating, and final settings.
11. Coil steam pressure and entering and leaving air temperatures.
12. Coil chilled water supply and return temperatures and entering and leaving air temperatures.
13. Coil heating water entering and leaving temperatures and entering and leaving air temperatures.
14. Condensing water supply and return temperatures.
15. Pump gpm, rpm, pressure, horsepower and service.
16. Electric heating elements voltage and amperage for each stage of heat.
17. Power Exhaust fan settings – cfm or % of supply airflow and power exhaust fan start point (% of outside air damper position).

18. CO2 controller set points – minimum CO2 setpoint (ppm), maximum CO2 setpoint (ppm)(setting for min OSA at full occupancy).
19. OSA intake damper settings at min occupancy and max occupancy (cfm or damper %)

1.4 DETAILED REQUIREMENTS

A. Include in the Contract Price, the cost of the mechanic’s labor required below.

B. Preparation by Contractor:

1. Prior to requesting that the adjusting and balancing be performed, bring the work to a state of readiness for adjusting and balancing.
2. Have all systems in complete operation and all calibrations complete.
3. Furnish a mechanic to assist the balancing firm with the adjusting and balancing.
4. Requests to perform the balancing prematurely and/or requests to perform the balancing in a piece-meal manner at the Contractor's convenience shall be at the Contractor's expense.

C. Adjusting and Balancing:

1. Mechanic's Duties: Include demonstrating that the system is functioning and operable, start and stop the fan, make drive changes, clear system blockages and repair any defective and/or leaking portions of the system which may affect system performance.
2. Prior to beginning the balancing work, obtain from the Architect the latest version of the mechanical drawings including addenda, revisions, change orders, etc.
3. Adjust and balance all portions of the mechanical systems to produce indicated results within limits of minus 5 or plus 10 percent or as subsequently directed by the Architect.
4. Balancing data may be spot checked with instruments similar to that used by the balancing firm.
5. If, in the judgment of the Architect, the discrepancies warrant additional adjustment, readjust and rebalance the systems at no additional project cost.
6. Adjust diffuser throws as shown on the drawings (shown as directional arrows)
7. Where power exhaust fans are specified, set power exhaust fans to operate as shown on drawings and set power exhaust fan cfm percentage as shown on drawing.
8. Set outside air intake dampers to modulate between min occupancy setting and max occupancy setting (as specified on drawings) as CO2 levels rise from minimum set point to maximum set point (as specified on drawings).

END OF SECTION

PART 1 - GENERAL

1.1 DESCRIPTION

A. The provisions of the General Requirements, Supplementary Requirements, and Division 1 apply to the electrical work specified in this Section.

B. The requirements of this Section apply to the electrical systems specified in these Specifications and in other Division 16 sections.

C. Provide all items, articles, materials, equipment, operations and/or methods listed, mentioned, shown and/or scheduled on the Drawings and/or in these Specifications, including all labor, supervision, services, permits, fees, and incidentals necessary and required to provide a complete and operable facility with complete systems as shown, specified, and required by applicable codes.

D. The work shall include, but not be limited to, the following systems:

1. Electrical service complete per serving utility company requirements.
2. Electric service and distribution equipment.
3. Complete lighting and power systems, including panelboards, branch circuits, devices, lighting fixtures, etc.
4. Telephone/data raceway system as indicated on the ‘T’ series drawings.
5. Fire alarm central control panel, initiating and annunciating devices, raceway and cabling system, etc on the ‘T’ series drawings.
6. Connection of electrical equipment furnished under other Divisions of this Specification.
7. Wiring to and connection of electrical equipment or appliances furnished outside of these Specifications and Contract but described on the Electrical Drawings.
8. Special systems as specified herein.
9. Grounding.

E. Advise subcontractor, suppliers, and vendors involved in the work specified in this Section of the applicable requirements.

F. Temporary electrical service, Division 1.

1.2 QUALITY ASSURANCE

A. All work and materials shall conform to all applicable local and state codes and all federal, state and other applicable laws and regulations. All clarifications and modifications which have been cleared with appropriate authorities are listed under the applicable sections. All electrical products shall bear the UL label.

B. Whenever the requirements of the Specifications or Drawings exceed those of the applicable code or standard, the requirements of the Specifications and Drawings shall govern.

C. Codes and Standards: Comply with the provisions of the following referenced codes, standards and specifications:

1. Institute of Electrical and Electronic Engineers (IEEE)
2. Federal Specifications (FS)
3. American National Standards Institute (ANSI)
4. National Electrical Manufacturer's Association (NEMA)

5. National Fire Protection Association (NFPA)
6. Underwriters Laboratories, Inc. (UL)
7. Factory Mutual (FM)
8. International Building Code (IBC) with State and Local Amendments
9. National Electrical Code (NEC) with State and Local Amendments
10. American Society for Testing and Materials (ASTM)
11. Americans with Disabilities Act (ADA)
12. International Fire Code (IFC) with State and Local Amendments
13. National Electrical Contractors Association (NECA)

D. Each piece of equipment furnished shall meet all detailed requirements of the Drawings and Specifications and shall be suitable for the installation shown. Equipment not meeting all requirements will not be acceptable, even though specified by name. Where two or more units of the same class of equipment are furnished, use product of the same manufacturer; component parts of the entire system need not be products of same manufacturer. Furnish all materials and equipment, new and free from defect and of size, make, type and quality herein specified or approved by the Architect. All materials shall be installed in a neat and professional manner.

E. All apparatus shall be built and installed to deliver its full rated capacity at the efficiency for which it was designed.

F. All disconnect switches, panelboards, switchboards, motor control centers, and equipment of like nature shall be of the same manufacturer.

G. The Drawings and Specifications are complementary. What is called for by one shall be as though called for by both.

1.3 WORK OF OTHER CONTRACTS

A. Work under this contract shall be conducted in a manner to allow for the future installations of such equipment or items, and include the wiring and/or devices shown on the Drawings or listed in other sections of this Specification. Also see "Equipment Connections."

1.4 WORK OF OTHER DIVISIONS

A. Work under this Division shall be conducted in a manner to cooperate with the installation of such equipment or items as specified in other Divisions.

B. Control devices and control wiring relating to the heating and air conditioning systems are specified under other Sections of these Specifications except for provisions or items specifically noted on the Drawings or specified herein.

C. Consult all Drawings and Specifications in this project and become familiar with all equipment to be installed. Coordinate all aspects of the construction with the other trades on the job to ensure that all work and materials required to provide a complete and operational facility are included in the bid.

D. All sections of Division 16 are interrelated and shall be considered in their entirety when interpreting any material, method, or direction listed in any section of Division 16. Individual sections are not written for specific subcontractors or suppliers but for the general contractor.

1.5 SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES

(SEE SECTION 01340 FOR REFERENCE)

A. Submit in accordance with Division 1 full technical and descriptive shop drawing data on proposed materials and equipment as detailed in each section.

B. The Contractor shall verify that all equipment submitted can be delivered and installed within the time constraints of the construction period.

C. Include the manufacturer, type, style, catalog number, complete specification, certified dimensions, and description of physical appearance for each item and option submitted. Reproduction of catalog data sheets shall be clean and legible to show all details, including gauge of metal used.

D. Include only information on exact equipment to be installed, not general catalogs of the manufacturer. Where sheets show proposed equipment as well as other equipment, identify proposed equipment with rubber stamp arrow or similar concise method. Catalog numbers shall clearly indicate all specified items and options.

E. Submit with each copy a transmittal letter verifying that all included equipment submittals have been carefully considered for quality, dimensions, function, and have been coordinated with the Drawings and Specifications. Guarantee that proposed materials will meet or exceed the quality and function of those specified.

F. Include wire run and connection diagrams for all signal and/or low voltage systems, including floor plans.

G. Submittal Review: The submittal review process is a means to determine quality control. The action noted to be taken (or where conflicts with the contract documents are not noted) shall not be interpreted by the Contractor as automatic "change orders." Approval of the data for substitution and shop drawings shall not eliminate the contractor’s responsibility for compliance with Drawings or Specifications, nor shall it eliminate the responsibility for freedom from errors of any sort in the data discovered prior to or after the review process. Deviations, discrepancies, and conflicts between the submittals and the Contract Documents shall be called to the Architect's attention in writing at the time of transmittal of the data.

H. Unless otherwise directed by Division 1, submittal data shall be in a 3-ring plastic binder with a clear plastic sleeve and a project identification sheet inserted. Arrange submittals numerically with specification sections identified on divider tabs. All required sections shall be submitted at one time.

1.6 PRODUCT SUBSTITUTION

A. Material other than those specified may be approved for this project providing a written request is submitted to the Architect prior to bid in accordance with Instructions to Bidders. Requests shall include complete specifications, dimensions, manufacturer and catalog number for each item for which approval is desired. If, in the opinion of the Architect or Engineer, the material is not complete or if it is not an acceptable substitute, he may reject it. The evaluation will be based solely on the material submitted.

B. Manufacturer’s accepted as a substitute during the addendum process, will be partially based on the claim that “its equivalent or superior to that specified” as stated on the substitution request form. A formal review of each item will take place during the submittal process. Items that are not equal to that specified and therefore not approved will be re-submitted with equal product. Approval of equal product as determined by the architect/engineer shall be at no additional cost to the owner or project. It is the responsibility of the contractor to ensure substituted products are equal to that specified. Additional information may be required for the

review of substitution items, which may include manufacturer’s footcandle calculations, product samples or any other information requested by the architect/engineer.

1.7 CHANGE ORDERS

A. All supplemental cost proposals by the Contractor shall be accompanied by a complete itemized breakdown of labor and materials without exception. At the Architect's request, the contractor's estimating sheets for the supplemental cost proposals shall be made available to the Architect. Labor must be separated and allocated for each item of work.

1.8 RECORD DOCUMENTS

A. Maintain a set of record drawings as directed in Division 1.

B. Keep Drawings clean, undamaged, and up to date.

C. Record and accurately indicate the following:

1. Depths, sizes, and locations of all buried and concealed conduits/cables.
2. Changes, additions, and revisions due to change orders, addenda, obstructions, etc. Eradicate extraneous information.

D. Make Drawings available when requested by Architect for review.

E. Submit as part of the required Project Closeout documents as indicated in Division 1.

F. Use standards set in contract documents. Note field modifications, all addenda and change order items on project record drawings. If deficiencies are found in either the quality or the accuracy of the drawings, they will be returned unapproved. Additional review of subsequent submissions shall be at the contractor’s expense.

1.9 OPERATING AND MAINTENANCE DATA

A. Upon completion of Contract and after no further action is noted as being required on catalog data submitted for review, submit multiple sets of Operating and Maintenance Manuals for inclusion in Owner's Maintenance Brochure as specified in Division 1. Operation and maintenance manuals shall include descriptive and technical data, maintenance and operation procedures, wiring diagrams, spare parts lists, service representatives, supplier for replacement parts, etc. Bind each set of Operating and Maintenance Manuals in 3-ring, continuous hinged, loose leaf binders organized with index and thumb-tab marker for each classification of equipment or data. See Division 1 for specified binders.

1.10 OPERATING AND MAINTENANCE INSTRUCTIONS

A. At the completion of the project, at a time scheduled by the Owner, assemble key mechanics, subcontractors, vendors, factory representatives and similar personnel required to explain all facets of maintenance and operation of the installed system to the Owner's personnel. Instructions shall include actual operation of systems and methods of maintenance.

1.11 ALTERNATE BIDS

A. Refer to Division 1, Section 01230 for possible effect upon Work of this Division.

1.12 WARRANTY

A. Furnish, prior to application for final payment, three copies of written and signed guarantee effective a period of one year from date of completion and acceptance of entire project; agree to correct, repair and/or replace defective materials and/or equipment or the results of defective workmanship without additional expense to the Owner. Where no response satisfactory to the Owner has occurred within three working days from the written report of a warranty covered defect, the contractor shall agree to pay for the cost of repair of the reported defect by a contractor of the Owner's choice.

B. Where the manufacturer's guarantee exceeds one year, the longer guarantee shall govern and include the Contractor's labor.

PART 2 - PRODUCTS

2.1 MATERIALS

A. All electrical products installed in this project shall be listed by Underwriters Laboratories, Inc., or be approved in writing by the local inspection authority as required by governing codes and ordinances.

B. All material shall be new and bear manufacturer's name, model number, electrical characteristics and other identification, and shall be the standard product of manufacturer regularly engaged in production of similar material.

C. All materials shall be of manufacturer's latest design, and of the best quality. The materials shall be manufactured in accordance with applicable standards listed under Quality Assurance.

2.2 ACCESS PANELS

A. Provide panels of adequate size for equipment requiring service and installed above plaster or gypsum board ceilings, behind walls or in furring. Furnish complete with correct frame for type of building construction involved. Size, number and location of access panels is not necessarily shown on Drawings. Use no panel smaller than 12" x 12" for simple manual access, nor smaller than 16" x 20" where personnel must pass through. Milcor Style A, K, L, or M panels or equivalent Bilco or Potter-Roemer as required by construction. Access panels shall maintain ceiling fire rating.

2.3 PAINTING

A. The work of this Division includes painting of the electrical items. All exposed conduits, boxes, surface raceways, etc. shall be painted per the Architect's direction. See Division 9 for additional painting requirements.

2.4 FIRE RATINGS

A. Electrical items (light fixtures, boxes, etc.) recessed into fire rated walls or ceilings shall be alcoved in gypboard enclosures or be UL listed to maintain the fire rating.

PART 3 - EXECUTION

3.1 LAYOUT AND COORDINATION

A. The Contractor shall inspect the job site prior to bidding and become familiar with existing conditions which will affect his work. The Drawings are diagrammatic indicating approximate location of outlets, lighting fixtures, electrical equipment, etc. Consult the Architectural, Structural and Mechanical Drawings to avoid conflicts with equipment, structural members, etc. When required, make all deviations from Drawings to make the work conform to the building as constructed, and to related work of others. Minor relocations ordered prior to installation may be made without added cost to the Owner.

B. Obvious omissions from Drawings or Specifications or differences between Drawings and Specifications shall be called to the Architect's attention at least ten (10) days prior to the bid date for clarification. Failure to do so will be construed as the willingness of this Contractor to supply all necessary materials and labor required for the proper completion of this work in a manner approved by the Architect.

C. Call to the attention of the Architect any error, conflict or discrepancy in Drawings and/or Specifications. Do not proceed with any questionable items of work until clarification of same has been made.

D. Supplementary details and plans may be supplied as required and they will become a part of the Contract Documents.

E. Work under this Division shall be conducted in a manner to cooperate with all other trades for proper installation of all items of equipment.

F. Coordination of work with other crafts employed on the project is mandatory. Arrange work to reduce interruption of existing services to minimum. When interruptions are unavoidable, consult Architect and utilities involved and agree in writing, with copy to the Architect, upon a mutually satisfactory time and duration.

G. Verify the physical dimensions of each item of electrical equipment to fit the available space and promptly notify the Architect prior to roughing-in if conflicts appear. Coordination of equipment to fit the available space and the access routes through the construction shall be the Contractor's liability.

H. Locations of items shown on the Drawings as existing are partially based on record and other drawings which may contain errors. The Contractor shall verify the correctness of the information shown prior to rough-in or demolition and notify the Architect of any discrepancies.

I. Coordinate all work and trim with carpet installers. Provide carpet plates on all carpet surfaces, complete as required.

J. Install equipment such that code-required working clearances are maintained, and allow clearances for future maintenance.

K. Coordinate installation of electrical conduit, boxes, fittings, anchors, and miscellaneous items to be concealed in precast concrete assemblies.

3.2 UTILITY COORDINATION

A. Utility Coordination: Coordinate all aspects of the incoming electrical, telephone and other utility services indicated with the city engineer, serving utility, and the off-street improvements contractor. Requirements of the utility company which exceed the provisions made on the Drawings or covered by these Specifications shall take precedence. Provisions made on the Drawings or Specifications in excess of the utility company's requirements shall take precedence. No additional compensation will be allowed the contractor for connection fees or

additional work or equipment not covered in the Drawings or Specifications which are a result of policies of the serving utilities.

B. The Contractor shall contact the serving utility representatives and verify if any charges will be rendered against this project. These charges, if any, shall be included within the basic bid figure.

1. The electric utility representative is: PPL– Rick Wheeler (541-858-3204)

3.3 EXCAVATING AND BACKFILL

A. Provide trenching, backfilling, compaction, repaving or other site restoration as required by the work done in this Division. Minimum trench depth shall be 36" unless otherwise noted. Install 6" wide red vinyl tape with lettering "Caution: Buried Electric Line Below" 18" above all buried electric lines in this contract.

B. Excavating and backfilling required for installation of electrical work shall be performed in accordance with requirements specified in Division 2. Backfill in excavations outside of building may be excavated material from site containing no rocks over 3/4" in diameter.

C. Provide all necessary backfill materials, whether from site excavations or from off-site borrows, to completely fill excavations. Coordinate patching of all asphalt or concrete surfaces disturbed by this work with the Owner.

D. Bored Crossings: Casing shall be smooth steel pipe fabricated in sections for welded joints, of size sufficiently large to provide adequate working space to properly install conduits, continuous butt welded at joints for rigid, watertight encasement, minimum thickness of 0.188” for casing under 14” diameter, and 0.281” for casings 14” and larger diameter.

3.4 PROTECTION OF WORK

A. Protect electrical work, wire and cable, materials and equipment installed under this Division against damage by other trades, weather conditions or any other causes. Equipment found damaged or in other than new condition will be rejected as defective.

B. Switchgear, panels, light fixtures and electrical equipment shall be kept covered or closed to exclude moisture, dust, dirt, plaster, cement, or paint and shall be free of all contamination before acceptance. Enclosures and trims shall be in new condition, free of rust, scratches or other finish defects. Properly refinish in a manner acceptable to the Architect if damaged.

C. Including products of other Sections, clean, repair and touch-up or replace when directed, products which have been soiled, discolored or damaged.

D. Provide for dehumidification of equipment during construction when directed by Architect.

E. Remove debris from project site upon completion or sooner if directed.

3.5 GENERAL INSTALLATION METHODS

A. Provide raceways and conduits for all electrical system wiring as specified herein. Class II or III systems wiring installed per Article 725 of NEC will be required to be installed in raceway unless otherwise indicated. When open wiring is permitted, raceways will be required in insulated walls and in other inaccessible areas. Low voltage wiring installed in return air plenums shall utilize plenum rated cable.

B. The extent of the branch circuiting and control wiring shown shall not be changed.

C. Cross or hash marks on power and lighting conduit runs indicate quantity of No. 12 minimum copper branch circuit conductors unless otherwise noted. Where such marks do not appear, provide conductors as required to provide an operable system, sized per local codes.

D. Repair surfaces damaged during installation to match adjacent undisturbed areas. Surface preparation, including cleaning and priming, shall be in accordance with the paint manufacturer's requirements.

E. Adjacent panelboards, component cabinets, terminal cabinets, trench duct, and wire gutter exposed in finished areas shall have matching trim and finish.

F. In general, the mounting heights shall be as noted on the Drawings or as listed below. Where no heights are indicated, request clarification from the Architect. Consult the Architectural, Structural, and Mechanical Drawings to avoid conflicts prior to roughing in. All dimensions are to the center of the device above finished floor unless specified otherwise. Lighting dimensions are to the bottom of suspended fixtures; mount panelboards 72" to top handle; mount devices above counters, 12" above counter or 4-1/2" above backsplash, whichever is greater; and receptacles in unfinished areas 48".

G. All raceways and wiring shall be concealed where possible. All wiring devices, recessed light fixtures, etc., shall be flush mounted unless otherwise noted.

H. Relays, panels, cabinets and equipment shall be level and plumb and installed parallel with structural building lines. All equipment and enclosures shall be suitable for the environmental conditions in which they will operate.

I. The Drawings do not indicate all items necessary. Provide associated equipment, materials, and labor as required for complete and operable systems.

3.6 CUTTING AND PATCHING

A. Under no conditions are beams, girders, footings or columns to be cut for electrical items unless so shown on Drawings or written approval obtained from the Architect.

B. Cutting, patching and repairing for the proper installation and completion of the work specified, including plastering, gypsum board, masonry work, concrete work, carpentry work and painting shall be performed by workers skilled in their respective trades.

C. Follow requirements specified in Division 1.

3.7 SLEEVES AND CHASES

A. Provide necessary rigid conduit sleeves, openings and chases where conduits or cables are required to pass through floors, ceilings or walls. Seal all openings around conduits against leaks and in a manner to maintain the fire rating of the structure penetrated. Prevent unnecessary cutting in connection with the finished work. Make all repairs and seals in a manner acceptable to the Architect.

3.8 NOISE CONTROL

A. The entire electrical system apparatus shall operate at full capacity without objectionable noise or vibration.

B. Outlet boxes at opposite sides of partitions shall not be placed back-to-back, nor shall straight-through boxes be employed, except where specifically permitted on the Drawings by note, to minimize transmission of noise between occupied spaces.

C. Contactors, transformers, starters, and similar noise-producing devices shall not be placed on walls which are common to occupied spaces unless specifically called for on the Drawings. Where such devices must be mounted on walls common to occupied spaces, they shall be shock mounted or isolated in such a manner as to effectively prevent the transmission of their inherent noise to the occupied space.

D. Ballasts, contactors, starters, transformers, and like equipment which are found to be noticeably noisier than other similar equipment on the project will be deemed defective and shall be replaced.

3.9 EQUIPMENT CONNECTIONS

A. Provide complete electrical connections for all items of equipment requiring such connections, including incidental wiring, materials, devices and labor necessary for a finished working installation.

B. Verify the rough-in and wiring requirements for all equipment provided under other Divisions of the work and requiring electrical connections with equipment supplier and installer prior to rough-in. Check the voltage and phase of each item of equipment before connecting. Motor connections shall be made for the proper direction of rotation. Pump motors shall not be test run until liquid is in the system and proper lubrication to all bearings in unit is checked. Minimum size flex for mechanical equipment shall be 1/2". Exposed motor wiring shall be jacketed metallic flex.

C. Conduit, wire and circuit breaker sizes for mechanical equipment and equipment furnished under other Divisions are based on the equipment ratings of one manufacturer. The equipment actually furnished may be of a different brand with different electrical characteristics. Conduit, wire and circuit breakers shall not be ordered or installed until exact electrical requirements are obtained. Responsibility for this coordination shall rest with the Contractor.

3.10 TESTS

A. Complete each system as shown or specified herein and place in operation except where only roughing-in or partial systems are called for. Each system shall be tested and left in proper operation free of faults, shorts, or unintentional grounds.

B. After the interior wiring system installation is completed, and at such time as the Owner may direct, the Contractor shall conduct an operating test for approval. The equipment shall be demonstrated to operate in accordance with the requirements of the Specification. The test shall be performed in the presence of the Owner or an authorized representative. The Contractor shall furnish all instruments and personnel required for the tests, and the Owner will furnish the necessary electric power. The Contractor shall submit in writing to the Owner upon completion of the project the measured ground resistance of each ground rod, indicating the location of the rod, the resistance, and the soil conditions at the time the measurements were made.

END OF SECTION

PART 1 - GENERAL

1.1 DESCRIPTION

A. Provide all raceways and fittings of specified type required for complete project. Install all systems in raceways unless specifically noted otherwise.

1.2 QUALITY ASSURANCE

A. Underwriters Laboratories, Inc., listed and NEC approved.

1.3 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Deliver raceways with Underwriters Laboratories, Inc., label and bearing manufacturer's name on each length.

B. Deliver fittings in manufacturer's original unopened and undamaged packages with labels legible and intact.

1.4 APPLICATION

A. Areas of Use:

Underground	PVC
Within poured Concrete (except slab-on grade) or CMU	GRC, IMC, PVC
Dry concealed interior locations, subject to damage	GRC, IMC, EMT
Exterior exposed locations	GRC
Dry interior exposed locations, not subject to damage	GRC, IMC, EMT
Hazardous Class I or II	GRC, IMC

B. Underground conduit shall be minimum 3/4" trade size and all 90 degree bends shall be GRC. PVC shall not be used inside building or in any exposed locations (interior or exterior). Unless otherwise approved, all conduits shall be installed under reinforcing steel.

C. Where the contractor elects to utilize PVC in lieu of GRC, the contractor shall provide supplemental ground bus in terminating switch and panelboards, and green ground wire in conduit according to code rules.

D. For the purposes of this section, poured concrete slabs on grade and under-the-building slabs are not classified as dry locations.

E. Flexible metal conduit will be permitted only where flexibility is necessary. Exceptions are connections to recessed light fixtures. Flexible metal conduit shall be used for connection to all equipment subject to movement or vibration such as motors, transformers, etc. Liquid-tight flexible metal conduit shall be used when moisture may be present and for exposed motor and equipment connections.

F. Surface raceway may be used only where specifically called for on the Drawings or in the Specifications.

G. Aluminum conduit is not permitted.

1.5 SUBMITTAL AND RECORD DOCUMENTATION

A. Submit product data for surface raceway and wireway.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Allied Tube & Conduit, Western Tube & Conduit, Triangle, Bridgeport, AFC, Carlon, Western Plastics, Alflex, or approved substitute. Wiremold, Walker, or approved substitute.

2.2 CONDUITS

A. Galvanized Rigid Conduit (GRC) shall be hot-dip zinc, galvanized inside and out, mild steel pipe manufactured in accordance with UL-6 and ANSI C80.1. All threads shall be galvanized after cutting.

B. Electrical Metallic Tubing (EMT) shall be steel only and shall comply with UL-797 and ANSI C80.3. Exterior shall be hot-dip zinc galvanized and interior protected by a corrosion-resistant lubricating coating.

C. Intermediate Metallic Conduit (IMC) shall comply with UL-1242 and ANSI C80.6. Exterior shall be hot-dip zinc galvanized and interior protected by a corrosion-resistant lubricating coating.

D. Rigid non-metallic conduit (PVC) polyvinyl chloride shall be schedule 40 unless otherwise noted, and shall comply with UL-651 and NEMA TC 2.

E. Surface raceway shall utilize snap-in cover and fittings as recommended by the manufacturer and shall comply with UL 5 standard. Material and size shall be as indicated on the Drawings.

F. Flexible metal conduit shall be steel and comply with UL 1 and ANSI standards. Liquid-tight flexible metal conduit shall comply with UL 360 and ANSI standards.

2.3 WIREWAYS

A. Gutters: Steel, painted, square in cross section, preformed knockouts on standard spacing, screw cover, suitable for environment.

B. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for a complete system.

2.4 FITTINGS

A. GRC and IMC shall be coupled and terminated with threaded fittings. Ends shall be bushed with insulating bushings equal to T&B 1220 or 1230 series.

B. Connectors and couplings for EMT shall be steel concrete tight compression type or set screw type with insulated throats on connectors. Indent type connectors shall not be used.

C. Conduits piercing a building waterproof membrane shall be provided with O-Z type FSR fittings.

D. Flexible metal conduit shall utilize screw-in type connectors. Couplings and set-screw type connectors are not permitted.

E. Seal-offs with filler fiber, compound, large removable cover. All components shall be of the same manufacturer.

F. Expansion Couplings:

1. Exposed Conduit Runs: Expansion couplings shall be weatherproof with external bonding jumper, providing at least 4” longitudinal movement with bushed conduit ends.
2. Concealed Conduit Runs: Expansion couplings shall be water tight with an internal bonding jumper and neoprene construction. The fitting shall allow 3/4” movement in any direction or deflection of 30 degrees from normal.

G. Locknuts shall be galvanized steel.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Ends of metal conduits shall be reamed and left free of burrs.

B. Provide pull boxes or vaults where shown or required to limit the number of bends in any conduit to not more than three 90 degree bends, or to ease pulling tension. Use boxes of code-required size with removable covers, installed so that covers will be accessible after work is completed.

C. Conceal all wiring in finished spaces so far as practicable. Exposed conduit shall be used only in unfinished spaces.

D. Exposed raceways shall be parallel or at right angles to structural lines, and shall be neatly offset into boxes. Exposed raceways shall follow existing exposed piping/ductwork/conduit paths as far as practicable.

E. Conduit stubbed from a concrete slab or wall to serve an outlet mounted on a table or to supply a machine shall have a rigid conduit coupling flush with the surface of the slab. Provide plug where conduit is to be used in future.

F. Keep conduit and raceway closed with suitable plugs or caps during construction to prevent entrance of dirt, moisture, concrete or foreign objects. Raceways shall be clean and dry before installation of wire and at the time of acceptance.

G. Remove all foreign matter from raceways and pull mandrel through conduits larger than 1-1/2" prior to installing conductors.

H. Where no conduit size is noted on the Drawings, conduit may be the minimum code permitted size for the quantity of type THHN conductors installed, but in no case smaller than 1/2" trade diameter. Conductor quantities indicated in conduits do not include ground wire unless otherwise noted. Adjust conduit sizes accordingly.

I. Where the contractor elects to combine branch circuit runs shown as separate runs on the Drawings, provide a minimum 3/4" conduit or increase raceway size to provide a minimum of 25 percent spare capacity for future conductors. Feeder runs shall not be combined.

J. All conduits installed in concrete construction, underground, or under the building slab shall be minimum 3/4", unless otherwise noted.

K. Assemble, glue and seal PVC conduit in straight lengths prior to installation in trench.

L. Seal-offs shall be installed in all conduits which route from warm areas into refrigerated areas.

M. Install PVC conduit in accordance with manufacturer's instructions. Cut the conduit ends square and apply an approved solvent to clean the joint. Apply an approved cement and allow to set 24 hours before installing conductors.

N. Conduits shall be fastened to all sheet metal boxes and cabinets with two locknuts where required by the National Electrical Code, where insulating bushings are used, and where bushings cannot be brought into firm contact with the box; otherwise, a single locknut and bushing may be used.

O. A pull wire shall be inserted into each empty raceway in which wiring is to be installed by others. The pull wire shall be of No. 15 AWG zinc-coated steel, or of plastic having not less than 200-pound tensile strength. Not less than 10" of slack shall be left at each end of the pull wire.

P. Raceway shall not be installed under the fire pits of boilers and furnaces and shall be kept 6" away from parallel runs of flues, steam pipes and hot water pipes.

Q. Changes in direction of runs shall be made with symmetrical bends or cast-metal fittings. Field-made bends and offsets shall be made with an approved hickey or conduit-bending machine. Crushed or deformed raceways shall not be installed.

R. Expansion fittings complete with grounding jumpers shall be installed where raceways cross expansion joints, construction joints, sawed joints, and where shown.

S. Where conduit is shown stubbed into a telephone, computer or communication terminal area, conduit shall be stubbed up 6" above floor or 12" below ceiling and terminated with insulating bushings.

T. Coordinate layout and installation of raceway and boxes with other construction elements to ensure adequate head room, working clearance, and access to both boxes and other equipment.

U. The end of a conduit stub shall have an insulated bushing.

V. Pack spaces around conduits with polyethylene backing rods and seal with polyurethane caulking to prevent entrance of moisture where conduits are installed in sleeves or block-outs penetrating partitions.

W. Install intumescent material around ducts, conduits, etc., to prevent spread of smoke or fire where installed in sleeves or block-outs penetrating fire-rated barriers. An alternate method utilizing intumescent materials in caulk and/or putty form may be used.

3.2 INSTALLING CONDUIT BELOW SLAB-ON-GRADE OR IN THE GROUND

A. All electrical wiring below slab-on-grade shall be protected by a conduit system.

B. No conduit system shall be installed horizontally within concrete slab-on-grade. For slab-on-grade construction, horizontal runs of rigid plastic shall be installed below the floor slab.

C. Conduit passing vertically through slab-on-grades shall be coated rigid steel.

D. Slope conduits away from terminal equipment; drain away from the building interior.

E. Rigid steel or IMC conduits, metal boxes, and couplings installed below slab-on-grade or in the earth shall be field-wrapped with 0.010" pipe-wrapping plastic tape applied with a 50 percent overlay, or shall have a factory applied plastic resin, epoxy, or coal-tar coating system. Zinc coating may be omitted from rigid steel conduit, or IMC which has a factory-applied epoxy system. All joints shall be threaded, sealed and wrapped with tape to prevent entry of water. Use 20 mil pipe wrapping tape to cover wrench marks, field cuts, or abrasions to the outer factory installed anti-corrosion covering.

F. Provide duct seal at ends of all underground and under-slab conduits.

END OF SECTION

PART 1 - GENERAL

1.1 DESCRIPTION

A. Provide all conductors, cables, connectors, lugs, cable ties, and terminations for all systems.

1.2 QUALITY ASSURANCE

A. All conductors shall be Underwriters Laboratories, Inc., listed and comply with Fed. Spec. J-C-30B and UL 83. Materials omitted here but necessary to complete the work are to be of comparable quality.

1.3 PRODUCT DELIVERY, STORAGE & HANDLING

A. Deliver conductors and cables in complete coils with UL label and bearing manufacturer's name, wire size, and type of insulation.

B. Store and handle materials so as not to subject them to corrosion or mechanical damage and in a manner to prevent damage from environment and construction operation.

C. Deliver conductors No. 10 and smaller in manufacturer's original unopened and undamaged cartons with labels legible and intact.

1.4 SUBMITTAL AND RECORD DOCUMENTATION

A. None required.

PART 2 - PRODUCTS

2.1 CONDUCTORS

A. Conductors No. 10 AWG and smaller may be soft-drawn, stranded, or solid copper. Conductors larger than No. 10 AWG shall be stranded, soft-drawn copper.

B. Insulation for new conductors installed in raceways shall be "THWN" for conductors No. 8 AWG or smaller, and "THWN" or "THHN" for conductors No. 6 AWG or larger, or as noted.

C. Where adverse conductor exposure exists, code-approved insulation suitable for the conditions encountered shall be used unless shown otherwise on the Drawings.

D. All wire and cable for feeder circuits shall conform to the latest requirements of the current edition of the NEC and shall meet all ASTM Specifications. Wire and cable shall be new and have wire size, grade of insulation, voltage, and manufacturer's name permanently marked on outer covering at regular intervals.

E. Sizes shall not be less than indicated. Branch circuit conductors shall not be smaller than No. 12 AWG. Class I remote control and signal circuit conductors shall not be less than No. 14 AWG. Class 2 low energy remote control and signal circuit conductors shall not be less than No. 18 AWG.

F. All insulation shall be rated 600 volts unless noted otherwise.

G. Acceptable Manufacturers: General Electric, Hatfield, Anaconda, Rome Cable, Essex, Belden, West Penn, or approved.

2.2 SPLICES AND TERMINATIONS

A. All connectors shall be solderless pressure type per Fed. Spec. W-S-610, properly taped. All taped joints shall be with plastic tape, "Scotch 33," applied in half-lap layers without stretching to deform.

B. Splices shall utilize Scotch "Hyflex" or "Ideal" wing nut connector installed properly. Splices for No. 8 and larger wires shall be made with tin or silver plated copper compression sleeves.

C. Splices made in handholes and manholes, or underground splices, shall be made water tight with epoxy resin-type splicing kits.

PART 3 - EXECUTION

3.1 CONDUCTORS

A. Insulation shall be removed with a stripping tool designated specifically for that purpose. All conductors shall be left nick-free.

B. UL listed pulling compounds may be used with the residue cleaned from the conductors and raceway entrances after the pull is made.

C. Raceway shall be complete, clean and free of burrs before pulling conductors.

D. Wire shall not be left extending out of exposed conduit stubs or incomplete raceways where subject to mechanical injury.

E. Pulleys or blocks shall be used for alignment of the conductors when pulling. Pulling shall be in accordance with manufacturer's specifications regarding tensions, bending radii of the cable and compounds.

F. Conductors shall be terminated as required.

G. Conductor sizes for special systems shall be as recommended by the equipment manufacturer except as noted.

H. Stranded conductors shall not be terminated with post and screw unless compression spade/ring lug is utilized.

I. 120-volt homeruns over 80 feet in length shall be minimum #10 conductor.

3.2 LABELING

A. Provide color coding of building wiring consistent throughout the work as listed herein, unless required otherwise by local code authority. Band feeder conductors not available in colors where clearly visible at each termination, tape or splice using two full wraps of 3/4" adhesive vinyl tape or equally visible color marking corresponding to the following table.

Less than 250V between phases	251 to 600V btwn phases
Phase A - Black	Phase A - Brown

Phase B - Red	Phase B - Orange
Phase C - Blue	Phase C - Yellow
Neutral - White	Neutral - Gray
Ground - Green	Ground - Green

B. Switch legs, travelers, etc., to be consistent with the above phases to which they are connected or may be any other color distinctive from those listed above. Complex control circuits may utilize any combination of colors but the identification shall be by labels throughout. Labeling shall be accomplished by using computer-generated heat shrink labels suitable for the wire size used. In no case will hand lettering or wraparound labels be accepted.

C. Phase color code to be consistent at all feeder terminations, A-B-C left to right or A-B-C top to bottom.

D. Conductor identification shall be provided within each enclosure where a tap, splice, or termination is made.

E. Control circuit terminals of equipment shall be properly identified. Terminal and conductor identification shall match that shown on approved shop drawings (see Section 01340 for reference). Hand lettering or marking is not acceptable.

3.3 SPLICES AND TERMINATIONS

A. Splices are to be made up completely promptly after wire installation. Single wire pigtails shall be provided for fixture and device connections. Wire nuts may be used for fixture wire connections to single wire circuit conductor pigtails.

3.4 CONNECTORS

A. Control and special systems wires shall be terminated with a tool- applied, spade-flared lug when terminating at a screw connection.

B. All screw and bolt-type connectors shall be made up tight and be retightened after an eight-hour period.

C. All tool-applied compression connectors shall be applied per manufacturer's recommendations and physically checked for tightness.

D. Check terminations in all panelboards, switchgear, motor control centers, etc., six months after completion of installation. Supply a confirming letter to the Owner at completion of test.

3.5 TESTS

A. Perform insulation resistance tests on all feeders and circuits over 100 A, 480 volt and below, with a 1,000 volt megger. The written test report listing the results of the test to be included in the Operating and Maintenance Manuals. Equipment which may be damaged by this test shall be disconnected prior to the test.

END OF SECTION

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Metal-clad cable may be used for concealed branch circuit wiring where permitted by local codes and NEC Article 330 except where otherwise noted in these specifications. Metal-clad cable shall be used only for concealed interior accessible wiring and shall be exposed only in unfinished crawl or ceiling spaces or attics.

1.2 SUBMITTAL AND RECORD DOCUMENTATION

A. Submit product data for metal-clad cable.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Cable shall be steel jacketed, interlock armor with internal, fully insulated, green grounding conductor and multi-conductor, thermoplastic, insulated, color-coded solid or stranded copper conductors No. 12 through No. 6 AWG, 600 volt.

B. Connections, terminations, and fasteners shall be malleable iron or steel saddle-type with anti-short insulated bushings.

2.2 APPROVED MANUFACTURERS

A. MC Cable: AFC/A Nortek Company, type MC, HCF-90.

B. Fittings: T&B 3110 series connectors with 390 series bushings.

C. Tools: Cable manufacturer approved type with controlled depth rotary cutter.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Support horizontal and vertical cable 6 feet on center (maximum) and within 6" of boxes with approved cable clamps.

B. Support cable above accessible ceilings; do not rest cables on ceiling tiles. Attach cables with metal clips or plastic cable ties to support wires from structure on 6-foot centers maximum.

C. Cable shall be cut with manufacturer-approved devices.

D. Splice conductors only in accessible junction boxes.

E. Cable shall not be supported from or come into contact with mechanical ducts, water, sprinkler or gas piping; maintain 6-inch separation minimum.

F. Provide junction box at all cable penetrations of wall, ceiling, or floor surfaces for equipment connections; cable shall not be run directly through finished surfaces.

G. Voltage Drop: Conductors over 75 feet for 120-volt, and over 200 feet for 277-volt for branch or individual circuit home runs from equipment connection; receptacle or lighting fixture shall be No. 10 AWG minimum.

H. Provide junction box at transition from concealed to exposed wiring. Exposed wiring shall conform to Section 16110 - Raceways.

I. Where cable penetrates fire-rated walls or floors, provide mechanical fire stop fitting with UL-listed fire rating equal to wall or floor rating.

J. Provide junction box at transition from interior to exterior wiring. Exterior wiring shall conform to Section 16110 - Raceways.

K. Provide EMT risers from panelboards up into accessible ceiling/attic space and down into accessible crawl/ceiling space, terminating in accessible gutter(s) or junction box(es). Wiring devices in walls shall have conduit stub-ups to accessible ceiling space.

END OF SECTION

PART 1 - GENERAL

1.1 DESCRIPTION

A. The requirements of this section apply to electrical boxes. Provide all outlet boxes, junction boxes, pull boxes and special boxes required for pulling of wires, making connections, and mounting of devices or fixtures.

1.2 QUALITY ASSURANCE

A. All boxes shall be Underwriters Laboratories, Inc., listed. Where special fabrication is required, the work shall be performed by a listed facility in accordance with UL 50, and all products of manufacture shall bear a label. Outlet and junction boxes shall be sized in accordance with NEC requirements for "THHN" wire or as noted on Drawings.

1.3 SUBMITTAL AND RECORD DOCUMENTATION

A. Submit product data for floor boxes. Submit shop drawings (see Section 01340 for reference) for nonstandard boxes, enclosures, and cabinets. Include layout drawings showing components and wiring.

PART 2 - PRODUCTS

2.1 BOXES

A. Boxes for use with raceway systems shall not be less than 4" square and 1-1/2" deep except where shallower boxes required by structural conditions are approved.

B. Flush and Concealed Outlet Boxes: Galvanized stamped steel with screw ears, knock-out plugs, mounting holes, fixture studs if required.

C. Surface Outlet Boxes: Galvanized stamped steel same as above for use on ceilings and walls above 14 feet.

D. Boxes shall be of the cast-metal hub type when located in normally wet locations and when surface mounted on outside of exterior surfaces.

E. Boxes installed for concealed wiring shall be provided with suitable extension rings or plastic covers as required.

F. Cast-metal boxes installed in wet locations and boxes installed flush with the outside of exterior surfaces shall be gasketed.

G. Provide boxes suitable for the intended environment and sized as required to accommodate the equipment within.

H. Pull boxes of not less than the minimum size required by the National Electrical Code shall be constructed of code-gauge aluminum or galvanized sheet steel except where cast-metal boxes are required in locations specified above. Boxes shall be furnished with screw-fastener covers. Where several feeders pass through a common pull box, the feeders shall be tagged to indicate clearly the electrical characteristics, circuit number, and panel designation.

I. Provide floorbox models as indicated on the drawings (or equal) and ensure that all necessary components are provided (i.e. device plates, leveling flanges, floor inserts for concrete or wood floor installation, access lids, trim inserts, etc.) for a complete finished installation.

J. All exterior ground level or in-ground junction boxes and pullboxes shall be manufactured by “Quazite”.

PART 3 - EXECUTION

3.1 MOUNTING

A. Outlet boxes shall be designed for the intended use. Flush outlet boxes shall be installed flush with finished surface lines.

B. Outlet boxes on flex connected fixtures shall be installed within five feet of conduit knock-out in fixture.

3.2 INSTALLATION

A. Coordinate layout and installation of raceway and boxes with other construction elements to ensure adequate head room, working clearance, and access to both boxes and other equipment.

END OF SECTION

PART 1 - GENERAL

1.1 DESCRIPTION

A. Provide all wiring devices and finish plates as required unless specifically indicated otherwise.

1.2 QUALITY ASSURANCE

A. Underwriters Laboratories, Inc., listed and NEC approved.

B. Wiring devices shall be specification grade, with special devices as noted on the Drawings. Should the Drawings indicate a device other than those listed herein, such device shall be of same grade and manufacture as specified below.

C. All lighting switches and duplex receptacles installed shall be from the same manufacturer and have identical appearance characteristics.

1.3 SUBMITTAL AND RECORD DOCUMENTATION

A. Submit product data for wiring devices and cover plates.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Wall Switches: 20 ampere, 120/277 volt AC, quiet type, Hubbell 1221 Series, “Gray” color or as selected by Architect. Single pole, double pole, 3-way, locking, or other type as indicated.

B. Receptacles: Single and duplex receptacles shall be rated 20 amperes, 125 volts, two-pole, three-wire, grounded type, Hubbell 5362 Series. Receptacles shall have nylon faces, one-piece brass mounting strap with integral ground contacts and bypass power contacts; “Gray” color or as selected by Architect.

C. Receptacles with ground fault interrupters shall be in accordance with UL 943, rated 20 amperes, 125 volts, Hubbell GF20 Series, “Gray” color or as selected by Architect.

D. Special purpose or heavy duty receptacles shall be of the type and of ratings and number of poles indicated or required for the anticipated purpose. Contact surfaces may be either round or rectangular. One appropriate straight or angle-type plug shall be furnished with each receptacle. Locking facilities, where indicated, shall be accomplished by the rotation of the plug.

E. Device plates of the one-piece type shall be provided for all outlets and fittings to suit the devices installed. Plates on unfinished walls and on fittings shall be of zinc-coated sheet steel, cast metal, or impact resistant plastic having rounded or beveled edges. Plates on finished walls shall be brushed #302 stainless steel.

F. Receptacles in wet locations shall be in a weatherproof enclosure, the integrity of which is not affected when the receptacle is in use. The enclosure shall be cast aluminum construction (Hubbell WP26 series, or equal). The enclosure shall be one or two-gang, and shall be secured

to the receptacle box with tamper-proof fasteners through factory-drilled or field-drilled through factory-prepared drill points.

2.2 ACCEPTABLE MANUFACTURERS

A. Hubbell, Bryant, P&S, and Leviton.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Devices and finish plates to be installed plumb with building lines.

B. Finish plates and devices not to be installed until final painting is complete. Scratched or splattered finish plates and devices will not be accepted.

C. Wall mounted receptacles shall be installed vertically at centerline height shown on the Drawings unless otherwise specified.

D. Plates shall be installed with all four edges in continuous contact with finished wall surfaces without the use of mats or similar devices. Plaster fillings will not be permitted. Plates shall be installed with an alignment tolerance of 1/16 inch.

E. All outlets shall have a cover plate. Provide blank cover plate to match surrounding area if none other is specified.

3.2 TESTS

A. Test all receptacles for line to line, line to neutral, line to ground, and neutral to ground, opens or shorts, and correct defective wiring.

3.3 LABELING

A. See Section 16195, Electrical Identification.

END OF SECTION

PART 1 - GENERAL

1.1 DESCRIPTION

A. Provide disconnect switches as indicated on the Drawings, in the Specifications, and where required by the National Electrical Code, even though not indicated. Provide fused or unfused switches as required by equipment manufacturer or circuit requirements.

1.2 QUALITY ASSURANCE

A. Underwriters Laboratories, Inc., listed.

1.3 SUBMITTAL AND RECORD DOCUMENTATION

A. Provide outline drawings with dimensions, and provide equipment ratings for voltage, amperage, horsepower, and short circuit.

PART 2 - PRODUCTS

2.1 DISCONNECTS

A. Enclosed safety switches shall be horsepower rated in conformance with Table III or Fed. Spec. W-S-865. Switches shall disconnect all ungrounded conductors.

B. Safety and disconnect switches shall be NEMA type HD (heavy duty), quick-make, quick-break, dual rated with electrical characteristics as required by the system voltage and the load served. Switches shall be equipped with a defeatable cover interlock. Operating handles shall be located to side of switches.

C. Enclosures shall be NEMA 1 for indoor use, unless specifically noted otherwise, NEMA 3R where installed exposed to the weather or designated by the subscript "WP".

D. Disconnects shall be fusible or non-fusible. Equip all fusible disconnects with dual element fuses required by the equipment served. Coordinate fuse sizes at the time equipment is connected. Adjust fuse sizes if necessary to accommodate actual equipment installed. In no case shall fuses be sized smaller than the starter heaters on motor circuits.

E. For single-phase motors, a single- or double-pole toggle switch, rated only for alternating current will be acceptable for capacities less than 30 amperes, provided the ampere rating of the switch is at least 125 percent of the motor rating.

F. All disconnects shall be of same manufacturer.

G. Switches identified for use as service equipment are to be labeled for this application.

2.2 ACCEPTABLE MANUFACTURERS

A. Siemens, Square D, Cutler-Hammer/Westinghouse, and GE approved.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install safety and disconnect switches where indicated, in accordance with the manufacturer's written instructions, the applicable requirements of NEC and the National Electrical Contractors Association's "Standard of Installation," and in accordance with recognized industry practices to ensure that products serve the intended function.

B. Install disconnect switches used with motor-driven appliances, motors, and controllers within sight of the controller position and within 25 feet.

END OF SECTION

PART 1 - GENERAL

1.1 DESCRIPTION

A. Provide all electrical equipment and wiring with adequate supports of specified type required for a complete installation.

1.2 SUBMITTAL AND RECORD DOCUMENTATION

A. Submit shop drawings (see Section 01330 for reference) indicating details of fabricated products and materials.

PART 2 - PRODUCTS

2.1 FASTENERS

A. Fastenings shall be by wood screws or screw-type nails to wood; by toggle bolts on hollow masonry units; by expansion bolts on concrete or brick; by machine screws, welded threaded studs, heat-treated or spring steel tension clamps on steel work; for new concrete installation use cast-in-concrete inserts. Kindorf D-255 or approved.

B. Hammer-driven and trigger-fired anchors may be used only after obtaining specific written authorization from the Architect.

2.2 OUTLET BOX SUPPORTS

A. Wood Stud Walls: Adjustable bar hangers with "C" channel cross section Steel City 6010 series, or approved, or mounted on solid blocking. 4-inch square boxes adjacent to wood studs may be side nailed and back braced with Steel City No. 50 box brace.

B. Light steel construction, bar hangers with 1-inch long studs between metal studs or metal stud "C" brackets snapped on and tab-locked to metal studs.

C. Concrete or masonry walls where boxes are not cast in place. Flush anchors or concrete inserts.

D. Flush Ceiling Outlets: Steel City 6010 series or equal bar hangers.

2.3 CONDUIT SUPPORTS

A. One Hole Malleable Straps: Steel City, Appleton, T&B, Diamond, Raco, or approved.

B. Conduit Clips: Caddy, Raco, or approved.

C. Nail-Up Straps: 1/2" through 1", Raco 2252, 2253, 2254, or approved.

D. Adjustable Hangers for Conduits 1-1/2" and Larger: Steel City C-149 with threaded steel rod of proper size.

E. Adjustable trapeze hangers to support groups of parallel conduits; Steel City B-905 steel channel, H-119 square washer, C-105 strap, threaded rod. Components of Unistrut, Globe Strut, Harvey Alstrut, Kindorf, Thomas & Betts, or approved.

2.4 HANGER ROD ATTACHMENTS

A. Side Beam Connector, Kindorf E-244; 90 degree fitting, Kindorf B-916; clamp type anchor clips Kindorf Type "C," Unistrut P2675 or approved, spot type concrete insert Kindorf B-255 with "Galv-Krom" finish.

2.5 SUPPORT CHANNELS

A. Conduit: Kindorf B-905 with Galv-Krom finish, and C-105 single bolt channel pipe straps.

B. Lighting: Kindorf B-900 with G-969 closure strip and G-977 swing connector.

C. Recessed in Concrete: Kindorf D-980 with D-982 anchored end caps and D-983 joiner clips.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Every fastening device and support for electrical equipment (includes fixtures, panels, outlets, conduits, and cabinets) shall be capable of sustaining not less than four times the ultimate weight of the object or objects. Fasten support to the building or a building structural member.

B. Provide independent supports to the building or building structural member for electrical fixtures, materials, or equipment installed in or on ceiling, walls, or in void spaces and/or over the furred or suspended ceilings. Chain or additional ceiling wires may be used for light fixture supports.

C. Other crafts' fastening devices shall not be used for the supporting means of electrical, equipment, materials, or fixtures.

D. Supports and/or fastening devices shall not be used to support more than one particular item.

E. Vertical support members for equipment and fixtures shall be straight and parallel to building walls.

F. Examine all equipment locations to determine type of supports required.

G. Raceways or pipe straps shall not be welded to steel structures.

H. Holes cut to a depth of more than 1-1/2" in reinforced concrete beams or to a depth of more than 3/4" in concrete joists shall avoid cutting the main reinforcing bars. Holes not used shall be filled.

3.2 BOXES

A. Boxes and pendants for surface-mounted fixtures on suspended ceilings shall be supported independently of the ceiling supports.

B. In open overhead spaces, cast metal boxes threaded to raceways need not be separately supported except where used for fixture support; cast metal boxes having threadless connectors and sheet metal boxes shall be supported directly from the building structure or by bar hangers.

C. Where bar hangers are used, the bar shall be attached to raceways on opposite sides of the box and the raceway shall be supported with an approved fastener not more than 24" from the box.

3.3 RACEWAYS

A. Support conduits within 18" of outlets, boxes, panels, cabinets, couplings, elbows, and deflections. Maximum distance between supports shall not exceed ten (10) foot spacing.

B. Conduit up to and including 1" EMT may be supported from ceiling fixture wires by conduit clips or other approved devices only with written approval of the installer of the ceiling support system. All other conduit runs shall be secured to the structure by two-hole straps or supported on Kindorf or Unistrut hangers. Wire will not be permitted for supporting conduit. All visible conduit runs will be parallel to the building structural lines.

C. Anchor conduit installed in poured concrete to the steel reinforcing with No. 14 black iron wire.

D. In partitions of light steel construction, sheet metal screws may be used, and bar hangers may be attached with saddle-suspended ceiling construction only. Lighting system branch circuit raceways shall be fastened to the ceiling supports.

E. Support suspended feeder conduits by metal ring or trapeze hangers with threaded steel rods. Wire ties to prevent displacement, using not less than No. 14 iron wire, may be used only for concealed runs in concrete for conduit up to 1-1/4".

F. At main distribution and surface mounted branch panels and cabinets where conduit exits from the top, provide support channels on wall 24" above panel and at 6'-0" intervals from there on for support of conduits.

END OF SECTION

PART 1 - GENERAL

1.1 DESCRIPTION

A. Clearly and properly label the complete electrical system to indicate the loads served or the function of each item of equipment connected under this work.

1.2 SUBMITTAL AND RECORD DOCUMENTATION

A. Submit product data for all identification labeling indicating material description, size, color, text size as proposed for the project.

PART 2 - PRODUCTS

2.1 IDENTIFICATION MARKERS

A. Unless otherwise specified, all identification nameplates shall be made of laminated three-ply plastic in accordance with Fed. Spec. L-P-387 equal to "Lamicoid." Nameplates shall be minimum 1/16" thick, with black outer layers and a white core, red outer ply for all emergency applications. Edges shall be chamfered.

B. Provide identification nameplates for starters, switchboards, safety switches, panelboards, motor control centers, transformers, equipment (air handling units, exhaust fans, pumps, etc.), with a minimum of 1/4" high letters.

C. Provide identification nameplates for control power transformers, control devices (relays, contactors, etc.), with a minimum of 1/8" high letters.

D. Where switches control remote lighting, exhaust fans, or power outlets, or where switches in the same gang (two or more) serve different purposes, such as light, power, intercom, etc., or different areas, such as corridor and outlet, furnish engraved cover plates with 1/8" black letters indicating function of each switch or outlet.

E. Provide identification labels for all wiring devices, including receptacles and switches. Labels shall be pressure sensitive adhesive machine typewritten 1/8" black letters indicating panel and circuit number serving device.

PART 3 - EXECUTION

3.1 LABELING

A. Major items of electrical equipment and major components shall be permanently marked with an identification nameplate to identify the equipment by type or function and specific unit number as shown on the Drawings.

B. Provide typewritten branch panel schedules with protective clear, transparent covers accounting for every breaker installed. Use actual room designations assigned by name or number near completion of the work, and not the designation on the construction drawings. Minimum panel schedule width shall be 4" with 1/4" height allowed for each circuit line. Panel

schedules shall be the type which install in a metal frame or pocket. Panel schedules shall be of the odd/even sequence (1-3-5-7-9... and 2-4-6-8-10...).

C. Identify service entrance and distribution switchboards with engraved nameplate corresponding with the plans, mounted on the face of the switchboard. Identify each feeder, breaker, and switch with engraved nameplate corresponding with the plans.

D. Identify branch panels with engraved nameplate corresponding with the main or subdistribution panel labeling, mounted on the face of the door. No brand labels or other markings shall be on the outside of the panels.

E. Label all disconnect switches, relays, contactors, starters and time switches indicating voltage, amperage, power panel source, circuit number and equipment served with laminated plastic label.

F. Nameplates shall be secured with screws or pop rivets. Adhesive-only fasteners shall not be permitted.

END OF SECTION

PART 1 - GENERAL

1.1 DESCRIPTION

A. Provide the secondary service entrance and metering equipment as specified herein and as shown on the Drawings.

1.2 COORDINATION

A. Coordinate all aspects of the incoming electrical utility service with the serving utility representative.

1.3 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Protect equipment against damage and moisture. Store materials off ground.

B. Deliver equipment with UL label and bearing manufacturer’s name.

1.4 QUALITY ASSURANCE

A. Underwriters Laboratories, Inc., listing/approval.

B. National Electrical Code with state and local amendments.

C. Serving utility requirements and guidelines.

1.5 SUBMITTAL AND RECORD DOCUMENTATION

A. Submit product data for products specified in this Section. Include dimensions, ratings, and data on features and components.

PART 2 - PRODUCTS

2.1 SWITCHBOARDS

A. Reference Section 16425, Switchboards.

2.2 PANELBOARDS

A. Reference Section 16470, Panelboards.

2.3 UTILITY METERING EQUIPMENT

A. Fabricated compartment and section meeting utility company’s requirements.

B. Bus work shall include provisions for mounting utility company current transformers and potential transformers or potential taps as required by the utility company.

2.4 CURRENT TRANSFORMER CABINET

A. Enclosure and cover to be fabricated from code gauge galvanized steel.

B. Enclosure body to have mounting holes on back.

C. Enclosure shall have mounting studs for utility current transformer mounting equipment.

D. Cover shall be held secure by sliding it under the top end flange and fastening.

E. Cover mounting studs and wing nuts shall have a utility sealing hole provision as well as a padlocking provision for sealing the cover to the enclosure.

F. Hinged cover handles shall fold against the cover when not used.

G. A ground lug shall be mounted on the inside bottom end of each cabinet.

H. Shall have ANSI 49 gray enamel paint finish.

I. Shall be UL 414 listed, type 3R, where installed outside.

J. Acceptable Manufacturer: Circle AW or equal.

2.5 CT RATED METER SOCKET

A. Enclosure and cover to be fabricated from code gauge galvanized steel.

B. Shall have lug range for #14 to #6 copper.

C. Shall have test perch drilled and tapped for test switches.

D. Shall have AWSR sealing ring.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install panels, cabinets and equipment level and plumb, parallel with structural building lines. Cover shall fit neatly without gaps, openings or distortion.

B. Install in accordance with the manufacturer’s installation instructions.

END OF SECTION

PART 1 - GENERAL

1.1 DESCRIPTION

A. Provide switchboards of a type indicated and specified herein, at locations shown on the Drawings

B. Utilization voltages shall be as noted on the one-line diagram or as indicated on the Drawings.

1.2 QUALITY ASSURANCE

A. Underwriters Laboratories, Inc., listing/approval.

B. U.L. Standard UL 891.

C. National Electrical Code.

D. NEMA Standard PB2.

1.3 SUBMITTAL AND RECORD DOCUMENTATION

A. Shop drawings (see Section 01330 for reference) shall indicate the following:

1. Front and side enclosure elevations with overall dimensions shown.
2. Conduit entrance locations and requirements.
3. Nameplate legends.
4. Size and number of horizontal bus bars per phase.
5. Neutral and ground.
6. One-line diagrams.
7. Equipment schedule.
8. Switchboard instrument details.

PART 2 - PRODUCTS

2.1 DISTRIBUTION ASSEMBLY

A. Each switchboard section shall be freestanding, dead-front type, rear-aligned, front accessible, and completely metal enclosed. Top and bottom conduit area shall be clearly shown and dimensioned on the Shop Drawings (see Section 01340 for reference). All front plate devices used for mounting switches or installed and laced with flexibility at the hinged side. Formed removable closure plates shall be used on the front, rear, and sides. All closure plates are to be single-tool, screw removable. Overcurrent devices shall be of size and type as indicated on the Drawings.

B. The paint finish shall be two coats gray enamel over a rust-inhibiting phosphate primer.

C. Main lugs shall be tool-applied compression-type.

D. The bus bars shall be tin-plated aluminum and rigidly braced for 65,000 amperes RMS symmetrical at rated voltage and sized as indicated on the Drawings. Main horizontal bus bars

shall be mounted with all three phases arranged in the same vertical plane. Provide a full capacity neutral bus. All unused space shall be bussed and left ready for future use.

E. A ground bus shall be firmly secured to each vertical section.

F. Board shall be service entrance rated where used as service entrance equipment.

G. All devices mounted in the switchboard shall have short circuit ratings to meet or exceed that of the switchboard.

H. Switchboard shall be tested, listed, and marked for use with a UL witnessed and recognized fuse/breaker combination.

I. Acceptable Manufacturers: Siemens, Square D, Cutler-Hammer/Westinghouse, and GE.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Distribution boards shall be free from surface and finish defects. All nameplates, labels, screws, bolts or other hardware shall be in place prior to acceptance.

B. Install panels, cabinets and equipment level and plumb, parallel with structural building lines. Switchgear panels and all electrical enclosures shall fit neatly without gaps, openings or distortion.

C. Neatly and securely lace the conductors of each circuit together as a group and not combined with other feeders. Support laced cables and securely tie at intervals no greater than three feet to support devices built into the switchgear assembly. No loose, unsupported wire or cable will be permitted, and lugs shall not support the conductor weight.

D. Provide engraved nameplates under the provisions of Section 16195, Electrical Identification.

3.2 CONCRETE BASE

A. Construct concrete equipment base 6” larger than footprint of cabinets and 3-1/2” tall. Where switchboard is outside, equipment base shall extend 4 feet in front of equipment as a flat level working surface.

B. Form concrete base using framing lumber with form-release compounds. Chamfer top edges and corners.

C. Install reinforcing bars and place anchor bolts and sleeves using manufacturer’s installation template.

D. Place concrete and allow to cure before installation of equipment.

END OF SECTION

PART 1 - GENERAL

1.1 DESCRIPTION

A. Provide ground system as specified herein, as shown on the Drawings, and as required by NEC and other rules and regulations pertaining to grounding.

1.2 SUBMITTAL AND RECORD DOCUMENTATION

A. None required.

PART 2 - PRODUCTS

2.1 GROUND CONDUCTORS

A. Equipment or grounding conductors shall be soft drawn copper, stranded per ASTM B8 and, if insulated, shall have green insulation.

2.2 GROUNDING BUSHINGS/WEDGES

A. Sufficient ampacity with grounding conductor set screw connection.

2.3 CONNECTOR

A. Cast, set screw or bolted type.

2.4 GROUND RODS

A. Copper-clad steel, not less than 3/4" in diameter, 8' long, driven full length into the earth.

PART 3 - EXECUTION

3.1 INSTALLATION

A. All grounding conductors shall be sized in accordance with Article 250, Tables 250-66 and 250-122 of the NEC.

B. Except where specifically indicated otherwise, all exposed non-current-carrying metallic parts of electrical equipment, metallic raceway systems, and neutral conductor of the wiring system shall be grounded.

C. The ground connection shall be made at the main service equipment and shall be extended to the point of entrance of the metallic water service. Connection to the water pipe shall be made by a suitable ground clamp. If flanged pipes are encountered, connection shall be made with the lug bolted to the street side of the flange connection.

D. Where the metallic water service is used, it shall be grounded as described by Article 250-53 of the NEC.

E. Generally, all supplemental grounding electrodes shall be ground rods.

F. All ground wire connections below finished grade, cast in concrete, or bonding solid wire shall be exothermically welded.

G. Where there is no metallic water service to the building, ground connections shall be made to driven ground rods on the exterior of the building.

H. The maximum resistance measured in accordance with IEEE Standard 142 of a driven ground shall not exceed 25 ohms under normally dry conditions. If this resistance cannot be obtained with a single rod, additional rods shall be installed not less than 6' on centers, or if sectional-type rods are used, additional sections may be coupled and driven with the first rod. If the resultant resistance exceeds 25 ohms measured not less than 48 hours after rainfall, the Engineer shall be notified immediately.

I. Grounding conductor connectors shall be made up tight and located for future servicing and to ensure low impedance.

J. The Contractor shall submit in writing to the Owner upon completion of the project the measured ground resistance of each ground rod, indicating the location of the rod and the resistance and the soil conditions at the time the measurements were made.

END OF SECTION

PART 1 - GENERAL

1.1 DESCRIPTION

A. Provide dry-type energy efficient transformers per NEMA TP1, with primary and secondary voltages of 600V and less and capacity ratings 15kVA through 750kVA.as specified herein and where shown on the Drawings.

1.2 SUBMITTAL AND RECORD DOCUMENTATION

A. Submit shop drawings (see Section 01330 for reference) indicating outline dimensions, connection and support points, weight, specified ratings, and materials. Include wiring diagrams of products, differentiating between manufacturer-installed and field-installed wiring.

1.3 STANDARDS

A. Transformers 750kVA and smaller shall be listed by Underwriters Laboratories.

B. Conform to the requirements of ANSI/NFPA 70.

C. Transformers are to be manufactured and tested in accordance with NEMA ST20.

D. Transformers losses shall conform to NEMA TP1 requirements

E. Transformers losses shall be tested in accord with NEMA TP2 procedures

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Acme, Siemens, Square D, Cutler-Hammer/Westinghouse, GE.

2.2 RATINGS INFORMATION

A. All insulating materials are to exceed NEMA ST20 standards and be rated for 220^{o}C UL component recognized insulation system.

B. Transformers 15kVA and larger shall be 150^{o}C temperature rise above 40^{o}C ambient. Transformers 25kVA and larger shall have a minimum of 4 - 2.5% full capacity primary taps. Exact voltages to be as designated on the plans or the transformer schedule.

C. The maximum temperature of the top of the enclosure shall not exceed 50^{o}C rise above a 40^{o}C ambient.

D. Transformers shall be low loss type with minimum efficiencies per NEMA TP1 when operated at 35% of full load capacity. Efficiency shall be tested in accord with NEMA TP2.

Single Phase		Three Phase	
kVA	Efficiency	kVA	Efficiency
15	97.7%	15	97.0%

25	98.0%	30	97.5%
37.5	98.2%	45	97.7%
50	98.3%	75	98.0%
75	98.5%	112.5	98.2%
100	98.6%	150	98.3%
167	98.7%	225	98.5%
250	98.8%	300	98.6%
333	98.9%	500	98.7%
		750	98.8%

E. The transformer(s) shall be rated as indicated on the drawings:

F. Provide weather-shields on transformers exposed to weather.

2.3 CONSTRUCTION

A. Transformer coils shall be of the continuous wound construction and shall be impregnated with nonhygroscopic, thermosetting varnish

B. All cores to be constructed with low hysteresis and eddy current losses. Magnetic flux densities are to be kept well below the saturation point to prevent core overheating. Cores for transformers greater than 500kVA shall be clamped utilizing insulated bolts through the core laminations to ensure proper pressure throughout the length of the core. The completed core and coil shall be bolted to the base of the enclosure but isolated by means of rubber vibration-absorbing mounts. There shall be no metal-to-metal contact between the core and coil and the enclosure except for a flexible safety ground strap. Sound isolation systems requiring the complete removal of all fastening devices will not be acceptable.

C. The core of the transformer shall be visibly grounded to the enclosure by means of a flexible grounding conductor sized in accordance with applicable UL and NEC standards.

D. The transformer enclosures shall be ventilated and be fabricated of heavy gauge, sheet steel construction The entire enclosure shall be finished utilizing a continuous process consisting of degeasing, cleaning and phosphatizing, followed by electrostatic deposition of polymer polyester powder coating and baking cycle to provide uniform coating of all edges and surfaces. The coating shall be UL recognized for outdoor use. The coating color shall be ANSI 49.

2.4 SOUND LEVELS

A. Sound levels shall be warranted by the manufacturer not to exceed the following:
15 to 50KVA - 45dB; 51 to 150kVA - 50dB; 151 to 300kVA - 55dB; 301 to 500kVA - 60dB; 501 to 700kVA - 62dB; 701 to 1000kVA - 64dB; 1001 to 1500kVA - 65dB; 1501 to 2000kVA- 66dB

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install all transformers, make flexible conduit connections to housing, make all cable connections, make ground wire connections.

B. Mount transformers on rubber sound/vibration isolators provided by manufacturer. Use mounting hardware and install according to manufacturer’s instructions.

C. No rigid connections shall be made to transformer.

D. Provide support and bracing for transformers to comply with seismic requirements of the area.

E. Leave a minimum clearance of 6” between transformer enclosure and non-combustible surfaces, and a minimum clearance of 12” between transformer enclosure and combustible surfaces.

END OF SECTION

PART 1 - GENERAL

1.1 DESCRIPTION

A. Provide at locations shown on the Drawings, panelboards of a type indicated and specified herein.

1.2 COORDINATION

A. Coordinate with other Trades affecting or affected by Work of this Section.

1.3 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Protect against damage and moisture. Store materials off ground. Remove damaged materials from site immediately after detection.

B. Deliver with UL label and bearing manufacturers name. Panelboard exterior trim separately packaged to prevent damage during delivery and storage on site.

C. Store and handle panelboards so as not to subject them to corrosion or mechanical damage and in a manner to prevent damage from environment and construction operation.

1.4 QUALITY ASSURANCE

A. Underwriters Laboratories, Inc. listing/approval.

B. Underwriters Laboratories, Inc. Standards.

1. Panelboards - UL67.
2. Cabinet and Boxes - UL50.

C. National Electrical Code.

D. NEMA Standard - PB1.

1.5 SUBMITTAL AND RECORD DOCUMENTATION

A. Approval documents shall include drawings. Drawings shall contain overall panel dimensions, interior mounting dimensions, and wiring gutter dimensions. The location of the main, branches, and solid neutral shall be clearly shown. In addition, the drawing shall illustrate one-line diagrams with applicable voltage systems. Include copy of panel schedules in record documents.

PART 2 - PRODUCTS

2.1 PANELBOARDS

A. Panels shall be factory pre-assembled using tin-plated aluminum bussing and bolt-on circuit breakers. Separate feeder lugs shall be provided for each feeder conductor. They shall be so designed that switching and protective devices can be replaced without disturbing adjacent

units and without removing the main bus connectors, so that circuits may be changed without machine drilling or tapping.

B. Branch circuits shall be arranged using double row construction except when narrow column panels are indicated. A nameplate shall be provided listing panel type and ratings.

C. Unless otherwise noted, full size insulated neutral bars shall be included. Bus bar taps for panels with single pole branches shall be arranged for sequence phasing of the branch circuit devices. Neutral bussing shall have a suitable lug for each outgoing feeder requiring a neutral connection. A separate ground bus shall be included in all panels. There shall be a neutral and ground bus space for each breaker location listed as space.

D. Panelboard boxes shall be at least 20" wide, made from galvanized steel. Provide minimum gutter space in accordance with National Electrical Code. Maximum panel depth shall be 5-3/4", unless otherwise shown or specifically approved by the Owner. Surface panel boxes shall be painted to match trim.

E. Switching device handles shall be accessible. Doors and panelboard trims shall not uncover any live parts.

F. All panel doors shall be provided with a flush type combination catch and lock with two milled keys. On doors more than 48" high, a three point combination catch and lock shall be provided with a vault type handle. All locks shall be keyed alike. All panel trims shall be "hinged front" (door on door) construction, meaning trim has a piano hinge down one side, door opens by a single latch, and entire trim hinges open by removing two screws.

G. Single pole breakers shall be full module size; two poles shall not be installed in a single module. Each breaker shall be securely fastened to prevent movement and trims shall fit neatly and tightly to the breaker assembly. Interrupting capacity shall be minimum 10,000 ampere or as indicated on the Drawings and shall conform to Fed. Spec. W-C-375. All 15 or 20 ampere single pole breakers shall have "switching-duty" capability.

H. Permanent numbers, engraved, stamped or painted shall be affixed to each pole next to breakers. Stick-on numbers are not acceptable.

I. Panelboards shall be coated with a rust inhibiting phosphate primer and two coats of light gray enamel. Trims to be separately packed and protected from scratching and marring.

J. Panelboards shall be tested, listed, and marked for use with a UL witnessed and recognized fuse/breaker combination.

2.2 ACCEPTABLE MANUFACTURERS

A. Siemens, Square D, Cutler-Hammer/Westinghouse, and GE.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Breaker handle guards shall be provided on each circuit supplying obviously constant loads to prevent accidental shutting off. Such loads are contactor controlled circuits, freeze protection, etc.

B. Provide typed schedules as in Section 16195.

C. Provide engraved laminated name plates under the provisions of Section 16195.

D. Provide one 3/4" spare conduit stubbed into an available accessible space above for every three single pole spare or space in new flush branch panels.

END OF SECTION

PART 1 - GENERAL

1.1 DESCRIPTION

A. At all locations shown, provide overcurrent protective devices of the size and type as specified on the Drawings and in the Specifications.

1.2 QUALITY ASSURANCE

A. The circuit breaker(s) referenced herein shall be designed and manufactured according to the latest revision of the following standards.

1. NEMA AB 1 - Molded Case Circuit Breakers and Molded Case Switches
2. UL 489 - Molded Case Circuit Breakers and Circuit Breaker Enclosures
3. UL 943 - Standard for Ground Fault Circuit Interrupters
4. CSA C22.2 No. 5.1 - M91 - Molded Case Circuit Breakers
5. NEC

1.3 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Deliver equipment with Underwriters Laboratories, Inc. label and bearing manufacturer's name.

1.2 SUBMITTAL AND RECORD DOCUMENTATION

A. Submit product data for each circuit breaker and fuse type, including descriptive data and time-current curves, let-through current curves for fuses with current limiting characteristics, and coordination charts and tables and related data.

PART 2 - PRODUCTS

2.1 MOLDED CASE CIRCUIT BREAKERS

A. General Requirements:

1. Circuit breakers shall be constructed using glass reinforced insulating material. Current carrying components shall be completely isolated from the handle and the accessory mounting area.
2. Circuit breakers shall have an over center, trip free, toggle operating mechanism which will provide quick-make, quick-break contact action. The circuit breaker shall have common tripping of all poles.
3. The circuit breaker handle shall reside in a tripped position between ON and OFF to provide local trip indication. Circuit breaker escutcheon shall be clearly marked ON and OFF in addition to providing International I/O markings.
4. The maximum ampere rating and UL, IEC, or other certification standards with applicable voltage systems and corresponding interrupting ratings shall be clearly marked on face of circuit breaker.
5. Each circuit breaker larger than 100A shall be equipped with a push-to-trip button, located on the face of the circuit breaker to mechanically operate the circuit breaker tripping mechanism for maintenance and testing purposes.
6. Circuit breakers shall be factory sealed with a hologram quality mark and shall have date code on face of circuit breaker.

7. Branch circuit breakers exposed to fault currents higher than their AIC rating shall be series-rated with upstream feeder breaker, unless noted otherwise on Drawings. Circuit breaker/circuit breaker and fuse/circuit breaker combinations for series connected interrupting ratings shall be listed by UL as recognized component combinations. Any series rated combination used shall be marked on the end use equipment along with the statement "Caution - Series Rated System. _____A Available. Identical Replacement Component Required".
8. Manufacturer shall provide electronic and hard copy time/current characteristic trip curves (and Ip & I^2t let through curves for current limiting circuit breakers) for each type of circuit breaker.
9. Circuit breakers shall be equipped with UL Listed electrical accessories as noted on the Drawings. Circuit breaker handle accessories shall provide provisions for locking handle in the ON and OFF position.
10. All circuit breakers shall be UL Listed for reverse connection without restrictive line and load markings and be suitable for mounting in any position.
11. Circuit breakers shall have factory installed mechanical lugs. All circuit breakers shall be UL Listed to accept field installable/removable mechanical type lugs. Lug body shall be bolted in place; snap in design not acceptable. All lugs shall be UL Listed to accept solid (not larger than #8 AWG) and/or stranded copper conductors.
12. All circuit breakers shall be capable of accepting bus connections.
13. Circuit breakers used for motor disconnects and not in sight of the motor controller shall be capable of being locked in the open (OFF) position.
14. Acceptable Manufacturers: Siemens, Square D, Cutler-Hammer/Westinghouse, and GE.

B. Thermal-Magnetic Circuit Breakers:

1. Circuit breakers shall have a permanent trip unit containing individual thermal and magnetic trip elements in each pole.
2. Thermal trip elements shall be factory preset and sealed. Circuit breakers shall be true rms sensing and thermally responsive to protect circuit conductor(s) in a 40 deg C ambient temperature.
3. Circuit breaker frame sizes above 100 amperes shall have a single magnetic trip adjustment located on the front of the circuit breaker.
4. Standard two- and three-pole circuit breakers up to 250 amperes at 600 VAC shall be UL Listed as HACR type.

C. Equipment Ground Fault Protection (in Thermal Magnetic Circuit Breakers):

1. Where indicated on the Drawings, circuit breakers shall be equipped with a Ground Fault Module.
2. Ground fault sensing system shall be modified zero sequence sensing type.
3. The ground fault system shall require no external power to trip the circuit breaker.
4. Companion circuit breaker shall be equipped with a ground-fault shunt trip.
5. The ground fault sensing system shall be suitable for use on grounded systems. The ground fault sensing system shall be suitable for use on three-phase, three-wire circuits where the system neutral is grounded but not carried through the system or on three-phase, four-wire systems.
6. Ground fault pickup current setting and time delay shall be field adjustable. A switch shall be provided for setting ground fault pickup point. A means to seal the pickup and delay adjustments shall be provided.
7. The ground fault sensing system shall include a ground fault memory circuit to sum the time increments of intermittent arcing ground faults above the pickup point.
8. A means of testing the ground fault system to meet the on-site testing requirements of the NEC shall be provided.
9. Local visual ground fault trip indication shall be provided.

10. Where noted on Drawings, the ground fault sensing system shall be provided with zone selective interlocking communication capabilities compatible with other thermal magnetic circuit breakers equipped with ground fault sensing, electronic trip circuit breakers with integral ground fault sensing and external ground fault sensing systems.
11. The companion circuit breaker shall be capable of being group mounted.
12. The ground fault sensing system shall not affect interrupting rating of the companion circuit breaker.

D. Electronic Trip Circuit Breakers:

1. Where indicated on Drawings, provide electronic trip circuit breakers per the following.
2. Breakers shall have a microprocessor-based tripping system which consists of three current sensors, a trip unit, and a flux-transfer shunt trip. The trip unit shall use microprocessor-based technology to provide the adjustable time-current protection functions. True RMS sensing circuit protection shall be achieved by analyzing the secondary current signals received from the circuit breaker current sensors and initiating trip signals to the circuit breaker trip actuators when predetermined trip levels and time delay settings are reached.
3. Interchangeable rating plugs shall establish the continuous trip ratings of each circuit breaker. Rating plugs shall be fixed type as indicated. Rating plugs shall be interlocked so they are not interchangeable between frames, and interlocked such that a breaker cannot be closed and latched with the rating plug removed. Circuit breakers shall be UL listed to carry 80% of their ampere rating continuously.
4. System coordination shall be provided by the following microprocessor-based programmable time-current curve shaping adjustments. The short-time pick-up adjustment shall be dependent on the long-time pick-up setting.
    a. Programmable long-time pick-up.
    b. Programmable long-time delay with selectable I^2t and I^4t curve shaping.
    c. Programmable short-time pick-up.
    d. Programmable short-time delay with selectable flat or I^2t curve shaping and zone selective interlocking.
    e. Programmable instantaneous pick-up.
    f. Programmable ground fault pick-up trip or alarm.
    g. Programmable ground fault delay with selectable flat or I^2t curve shaping and zone selective interlocking.

    The microprocessor-based trip unit shall have a powered/unpowered selectable thermal memory to provide protection against cumulative overheating should a number of overload conditions occur in quick succession.
5. Means to seal the trip unit adjustments in accordance with the NEC shall be provided.
6. Local visual trip indication for overload, short circuit and ground fault trip occurrences shall be provided.
7. An ammeter to individually display all phase currents flowing through the circuit breaker shall be provided. Indication of inherent ground fault current flowing in the system shall be provided on circuit breakers with integral ground fault protection. All current values shall be displayed in true rms with 2% accuracy.
8. Long Time Pickup indication to signal when loading approaches or exceeds the adjusted ampere rating of the circuit breaker shall be provided.
9. The trip system shall included a Long Time memory circuit to sum the time increments of intermittent overcurrent conditions above the pickup point. Means shall be provided to reset Long Time memory circuit during primary injection testing.
10. Circuit breakers shall be equipped with back-up thermal and magnetic trip system.
11. Circuit breaker trip system shall be equipped with an externally accessible test port for use with a Universal Test Set. Disassembly of the circuit breaker shall not be required for testing. Test set shall be capable of verifying the operation of all trip functions with or without tripping the circuit breaker.

2.2 FUSES

A. Fuses 0 through 600 amperes:

1. Circuits protected with fuses 0 through 600 amperes shall be protected by current-limiting Class RK1 or J dual-element time-delay fuses.
2. All fuses shall have separate overload and short-circuit elements.
3. Fuses shall incorporate a spring activated thermal overload element that has a 284 degrees Fahrenheit melting point alloy.
4. The fuses shall hold 500% of rated current for a minimum of 10 seconds with an interrupting rating of 300,000 amperes RMS symmetrical, and be listed by a nationally recognized testing laboratory.
5. Peak let-through currents and i2t let-through energies shall not exceed the values established for Class RK1 or J fuses.

B. Fuses 601 through 6000 amperes:

1. Circuits protected with fuses 601 through 6000 amperes shall be protected by current-limiting Class L time-delay fuses.
2. Fuses shall employ "O" rings as positive seals between the end bells and the glass melamine fuse barrel.
3. Fuse links shall be pure silver (99.9% pure) in order to limit the short-circuit current let-through values to low levels and comply with NEC Sections requiring component protection.
4. Fuses shall be time-delay and shall hold 500% of rated current for a minimum of 4 seconds, clear 20 times rated current in 0.01 seconds or less, with an interrupting rating of 300,000 amperes RMS symmetrical, and be listed by a nationally recognized testing laboratory.
5. Peak let-through currents and i2t let-through energies shall not exceed the values established for Class L fuses.

C. Spares: Upon completion of the project, the contractor shall provide the owner with the following:

1. 10% (minimum of 3) of each type and rating of installed fuses shall be supplied as spares.
2. Spare fuse cabinet(s) shall be provided to store the above spares.

D. Acceptable Manufacturers: Bussman, Littelfuse, and Gould-Shawmut.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install overcurrent protective devices as indicated, in accordance with manufacturer's written instructions and with recognized industry practices to ensure that protective devices comply with requirements. Comply with NEC and NEMA standards for installation of overcurrent protective devices.

B. Coordinate with other work, including electrical wiring work, as necessary to interface installation of overcurrent protective devices with other work.

C. Fasten circuit breakers without causing mechanical stresses, twisting or misalignment being exerted by clamps, supports, or cabling.

D. Inspect circuit breaker operating mechanisms for malfunctioning and, where necessary, adjust units for free mechanical movement.

E. Adjust all adjustable/programmable features of electronic trip circuit breakers in accordance with results of electrical power system studies. Reference Section 16476.

F. Fuses shall not be installed until equipment is ready to be energized. This measure prevents fuse damage during shipment of the equipment from the manufacturer to the job site, or from water that may contact the fuse before the equipment is installed.

3.2 TESTING

A. Prior to energization of overcurrent protective devices, test devices for continuity of circuitry and for short circuits. Correct malfunctioning units, and then demonstrate compliance with requirements.

END OF SECTION

PART 1 - GENERAL

1.1 DESCRIPTION

A. Provide transient voltage surge suppression equipment of a type indicated and specified herein, at locations shown on the Drawings

B. Utilization voltages shall be as noted on the one-line diagram.

1.2 QUALITY ASSURANCE

A. Underwriters Laboratories, Inc., listing/approval.

B. U.L. Standard UL 1449 Rev. 2 "Transient Voltage Surge Suppressors."

C. National Electrical Code.

D. Product must be made by a company engaged in the manufacture of such devices for a minimum of 10 years.

E. Source limitations: Obtain suppression devices from a single manufacturer.

F. IEEE Compliance: Comply with ANSI/IEEE C62.41, "IEEE Guide for Surge Voltages in Low Voltage AC Power Circuits" and test devices in accordance with ANSI/IEEE C62.45, "IEEE Guide for Surge Suppressor Testing."

G. NEMA Compliance: Comply with NEMA LS-1 "Low Voltage Surge Protective Devices."

1.3 SUBMITTAL AND RECORD DOCUMENTATION

A. Product Data: For each type of product indicated. Include operating voltage, rated capacities, operating temperature, shipping and installed weights, and items per Part 2 - Products.

B. Field Test Reports: Written reports of tests specified in Part 3 of this Section. Include the following:

1. Test procedures used.
2. Test results that comply with requirements.
3. Failed test results and corrective action taken to achieve requirements.

C. Maintenance Data: To include installation instructions, operation and maintenance manuals specified in Division 1.

D. Warranties: Special warranties specified in this Section.

1.4 PROJECT CONDITIONS

A. Placing into Service: Do not energize or connect service entrance equipment or panelboards to their sources until the surge protective devices are installed and connected. Do not single-phase, hi-pot or megger Service Entrance Equipment without disconnecting the surge protection device, as damage may result from these procedures to the surge protective device.

B. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:

1. Notify Architect not less than two days in advance of proposed utility interruptions.
2. Do not proceed with utility interruptions without Architect's written permission.

C. Service Conditions: Rate surge protective devices for continuous operation under the following conditions, unless otherwise indicated:

1. Maximum Continuous Operating Voltage: Not less than 125% of nominal system operating voltage for 120/240V Single-Phase or 208Y/120V Wye systems. Not less than 115% for 480Y/277V Wye or 480V Delta systems.
2. Operating Temperature: -40 to +185 degrees F (-40 to +85 degrees C)
3. Humidity: 0 to 95%, noncondensing.
4. Altitude: Less than 20,000 feet (6,000 meters) above sea level.

1.6 COORDINATION

A. Coordinate location of field mounted surge suppressors to allow adequate clearances for maintenance, clearance per NEC and all local electrical codes.

1.7 WARRANTY

A. General Warranty: Special warranties specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.

B. Special Warranty: Written warranty, executed by manufacturer agreeing to repair or replace components of surge suppressors that fail in materials or workmanship within the following:

1. Ten years (120 months) from date of Substantial Completion for service-entrance model.
2. Five years (60 months) from date of Substantial Completion for panelboard model.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements of this specification herein, provide products by one of the following manufacturers:

1. Intermatic, Inc.
2. Wiremold.
3. Leviton.
4. Transtector Systems, Inc.
5. LEA International
6. Square D
7. Cutler-Hammer
8. Siemens
9. GE

B. This specification is performance based, and any other vendors who desire approval to bid this project shall refer to Section 16050 for product substitution request instructions.

2.2 SERVICE ENTRANCE TYPE SURGE SUPPRESSION

A. Surge Protection Device Description: With the following features and accessories:

1. LED indicator lights for power and protective status.
2. Utilizing metal oxide varistor technology.
3. Integral EMI/RFI Filter providing up to 54 dB of attenuation from 20kHz to 100 MHz, which is UL1283 Listed.
4. Internal surge fuses rated at a minimum of 200 KA interrupting capacity.
5. Including thermal protection for each component, which is continuously monitored.
6. Internal surge module easily replaceable.
7. Integral Form C Contacts for remote indication of suppression status via connection to building management system (BMS provided by other Section of these Specifications)
8. Integral Audible Alarm with silence switch.
9. Nema 3R enclosure suitable for indoor or outdoor installation.

B. Single Impulse Surge Current Capacity shall be as follows:

1. 125KA Line to Neutral, Line to Ground, Line to Line, and Neutral to Ground.

C. UL 1449 (6KV, 500 Amp) let-through voltages as follows:

Mode	120/240V, 1-ph	208Y/120V, Wye	120/240V Delta	480Y/277V Wye
L-N	460V	460V	460V/632V	873V
L-G	480V	480V	480V/664V	857V
N-G	512V	512V	512V	774V
L-L	763V	763V	935V	1,523V

D. Part Number: Intermatic "PG4000" series or equal by approved vendor.

2.3 PANELBOARD TYPE SURGE SUPPRESSION

A. Surge Protective Device Description: With the following features and accessories:

1. LED indicator lights for power and protective status.
2. Utilizing metal oxide varistor technology.
3. Internal fuses rated at a minimum of 100KA interrupting capacity.
4. Including thermal protection for each component, which is continuously monitored.
5. Nema 1 enclosure suitable for indoor installation.
6. Flush mounting plate available for flush mount installations.

B. Single Impulse Surge Current Capacity shall be as follows:

1. 26KA Line to Neutral, Line to Ground, Line to Line, and Neutral to Ground.

C. UL 1449 (6KV, 500 Amp) let-through voltages as follows:

Mode	120V 1-ph	120/240V, 1-ph	208Y/120V, Wye	120/240V Delta	480Y/277V Wye
L-N	419V	376V	392V	392V/627V	791V
L-G	435V	389V	385V	385V/635V	775V
N-G	416V	365V	375V	373V	396V
L-L	N/A	635V	644V	661V	1,240V

D. Part Number: Intermatic "EH" series or equal by approved vendor.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install devices at service entrance, distribution panels, and panelboards as indicated on electrical one-line diagram.

B. Provide multi-pole, 60 Amp circuit breaker as a dedicated disconnect for the suppressor at Service Entrance location, unless otherwise indicated on drawings.

C. Install devices per manufacturer's instructions with conductors between suppressor and points of attachment as short and as straight as possible. Do not mount internal to switchgear, to facilitate ease of future maintenance and/or replacement.

D. Provide multi-pole, 30 Amp breaker as a dedicated disconnect for the suppressor at panelboard locations, unless otherwise indicated on drawings.

3.2 CONNECTIONS

A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.3 FIELD QUALITY CONTROL

A. Testing: Perform the following field quality control testing:

1. After installing the surge protective devices, but before electrical circuitry has been energized, test for compliance with requirements (voltage, temperature, etc.)
2. Complete start-up checks and voltage verifications according to manufacturer's written instructions.
3. Perform visual and mechanical inspection on each unit. Certify that units are installed per manufacturer's recommendations.

B. Repair or replace malfunctioning units. Retest after repairs or replacements are made.

END OF SECTION

PART 1 - GENERAL

1.1 DESCRIPTION

A. Provide all lighting outlets indicated on the Drawings with a fixture of the type designated and appropriate for the location. Outlet symbols on the Drawings without a type designation shall have a fixture the same as those used in similar or like locations.

B. Provide lamps for all fixtures.

C. Coordinate installation of fixtures with the ceiling installation and all other trades to provide a total system that is neat and of orderly appearance.

1.2 QUALITY ASSURANCE

A. Fixtures shall conform to the following specifications.

B. Manufacturers specified are indicative of the general type and performance desired and are not intended to restrict selection to fixtures of any particular manufacturer. Fixtures of similar designs and equivalent light distribution and brightness characteristics, and of equal finish and quality will be acceptable if approved by the Architect prior to the bid.

C. Equality shall be determined by comparisons of performance, construction, installation ease, maintenance, and appearance.

D. All light fixtures shall be UL listed and labeled.

1.3 SUBMITTAL AND RECORD DOCUMENTATION

A. Submit product data describing fixtures, lamps, ballasts, and emergency lighting units. Arrange product data for fixtures in order of fixture designation. All accessories and options proposed on data sheets shall be easily identified by highlighting arrow to determine compliance with contract documents.

B. Include data on features and accessories and the following information.

1. Outline drawings of fixtures indicating dimensions and principle features.
2. Electrical ratings and photometric data with specified lamps and certified results of laboratory tests.
3. Data on batteries and chargers of emergency lighting units.

C. Submit shop drawings (see Section 01330 for reference) from manufacturers detailing nonstandard fixtures and indicating dimensions, weights, methods of field assembly, components, features, and accessories.

PART 2 - PRODUCTS

2.1 FLUORESCENT FIXTURES

A. Ballasts for linear T8 lamps shall be as follows:

1. General:
   a. Electronic ballasts shall meet ANSI C82.11-1993 for high frequency fluorescent lamp ballasts.
   b. Ballast shall be high frequency electronic type and operate lamps at a frequency above 42 kilohertz to avoid interference with infrared devices.
   c. Provide constant light output throughout maximum input voltage variations of plus or minus 10 percent from nominal 120 volt or 277 volt.
   d. Ballast shall comply with FCC Part 18 Non-Consumer Equipment, Class A for EMI (conducted) and (radiated).
   e. Total harmonic distortion of the input current shall not exceed 10 percent for low and normal ballast factor ballasts, and 20 percent for high ballast factor ballasts.
   f. Power Factor: Greater than or equal to 95%, unless otherwise noted.
   g. Provide ballasts, which meet requirements of UL 935 and bear the appropriate UL label.
   h. Sound Ratings: Rating A, provide quietest rating available. If noisy ballasts are identified by the Owner or its representative of UL 935 and bear the appropriate UL label.
   i. Thermal Protection: Internal UL Class P.
   j. Input Voltage: Match branch circuit supply voltage.
   k. Manufacturer shall provide written warranty against defects in material or workmanship, including replacement, for five years from date of manufacturer.

2. High Efficiency Instant Start “Low Ballast Factor” Electronic Ballasts shall be as follows:
   a. Ballast factor of .78
   b. <10% THD
   c. 98% power factor
   d. Universal voltage range of 120V or 277V
   e. 48 input watts (98 lumens per watt) for (2)T832 watt lamp system
   f. Ballast shall have a minimum starting temperature of -20 deg F.
   g. Ballast shall have a Class A sound rating.
   h. Ballast shall be UL listed, Class P and Type 1 Outdoor and CUL certified.

   i. Manufacturer: Osram/Sylvania ‘Quicktronic’ series QHE or equal. Substitutions must be approved by the Architect &/or Engineer.

3. High Efficiency Instant Start “Normal Ballast Factor” Electronic Ballasts shall be as follows:
   a. Ballast factor of .88
   b. <10% THD
   c. 98% power factor
   d. Universal voltage range of 120V or 277V
   e. 55 input watts (98 lumens per watt) for (2)T832 watt lamp system
   f. Ballast shall have a minimum starting temperature of -20 deg F.
   g. Ballast shall have a Class A sound rating.
   h. Ballast shall be UL listed, Class P and Type 1 Outdoor and CUL certified.

   i. Manufacturer: Osram/Sylvania ‘Quicktronic’ series QHE or equal. Substitutions must be approved by the Architect &/or Engineer.

4. High Efficiency Program Start “Low Ballast Factor” Electronic Ballasts shall be as follows:
   a. Ballast factor of .71
   b. <10% THD

c. 98% power factor
d. Voltage range of +/-10%
e. 47 input watts (94 lumens per watt) for (2)T832 watt lamp system
f. Ballast shall have a minimum starting temperature of -18C (0 deg F).
g. Ballast shall have a Class A sound rating.
h. Ballast shall be UL listed, Class P and Type 1 Outdoor and CSA certified.

i. Manufacturer: Osram/Sylvania 'Quicktronic PSX series QTP' or equal. Substitutions must be approved by the Architect &/or Engineer.

5. High Efficiency Program Start "Normal Ballast Factor" Electronic Ballasts shall be as follows:
   a. Ballast factor of .88
   b. <10% THD
   c. 99% power factor
   d. Voltage range of +/-10%
   e. 60 input watts (94 lumens per watt) for (2)T832 watt lamp system
   f. Ballast shall have a minimum starting temperature of -18C (0 deg F).
   g. Ballast shall have a Class A sound rating.
   h. Ballast shall be UL listed, Class P and Type 1 Outdoor and CSA certified.

   i. Manufacturer: Osram/Sylvania 'Quicktronic PSX series QTP' or equal. Substitutions must be approved by the Architect &/or Engineer.

B. Ballasts for compact fluorescent lamps shall be as follows:

1. Provided with poke-in wire trap connectors, color-coded to ANSI standard.
2. Ballast shall be available in a plastic/metal can construction to meet plenum requirements.
3. Ballast shall be Programmed Start.
4. Ballast shall contain auto restart circuitry to restart lamps without resetting power.
5. Ballast shall operate from 50/60Hz input source of 120V or 277V with sustained variations of +/- 10%.
6. Ballast power factor shall be >98%.
7. Ballast shall be high frequency electronic type and operate lamps at a frequency above 50 kHz.
8. Ballast shall provide for a Lamp Current Crest Factor of 1.7 or less for primary lamp and 1.6 or less for all others.
9. Ballast input current shall have Total Harmonic Distortion (THD) of less than 10% when operated at nominal line voltage with primary lamp.
10. Ballast shall have a Class A sound rating.
11. Ballast shall have a minimum starting temperature of -18C (0 deg F).
12. Ballast shall provide Lamp EOL Protection Circuit.
13. Ballast shall tolerate sustained open circuit and short circuit output conditions without damage.
14. Ballast shall be UL listed, Class P and Type 1 Outdoor and CUL certified.
15. Ballast shall comply with ANSI standards for Transient protection.
16. Ballast shall comply with FCC regulations, Non-Consumer (Class A) for EMI/RFI.
17. Minimum five year ballast and complete replacement labor warranty by manufacturer.
18. Approved manufacturers: Advance Transformer 'Smartmate,' Sylvania, GE.

C. T8 linear fluorescent lamps shall be as follows:

1. F32T8, High Performance Lamps: Unless otherwise noted, 4100K correlated color temperature (CCT), color rendering index (CRI) greater than or equal to 85, initial light output greater than or equal to 3100 lumens, lamp lumen depreciation greater than or equal to 0.94, 24,000-hour lamp life at 3 hours per start when powered by rapid start ballast. Initial lumens per watt greater than or equal to 95. Compliant with federal TCLP requirements. Length and wattage as noted in Schedule 1, Scope of Work. Sylvania XPS Ecologic, Philips Alto Advantage, GE Ultra or approved substitution.

D. Compact fluorescent lamps shall be as follows:

1. CFT (twin tube-2 pin), CFQ (quad tube-4 pin), CFT (triple tube-4 pin), FT (long tube-4 pin).
2. 4100 K color temperature.
3. Wattages as noted on Lighting Fixture List
4. Amalgam technology
5. 82 CRI
6. 12,000 hours average rated life
7. Compliant with Federal Toxic Characteristic Leaching Procedure (TCLP).
8. Approved manufacturers: Sylvania, Philips, General Electric.

E. Miscellaneous:

1. All surface-mounted fluorescent lighting fixtures shall have low density label.
2. All recessed fluorescent lighting installed in fire-rated ceilings shall be provided with fire-rated protective covers per UL standards.
3. All fixtures mounted outdoors or in unheated spaces shall have 0 degree F ballasts.

2.2 RECESSED FIXTURES

A. In insulated ceilings, recessed fixtures to be equipped with “IC” rated housing or with a field fabricated fireproof box (metal, sheet rock, etc.), complying fully with all clearance requirements.

B. Recessed troffers shall be as follows:

1. Diffusers shall be pattern 12 extruded clear acrylic plastic, 0.125" overall thickness, unless otherwise specified in the fixture schedule by catalog number or remarks. Door shall be securely closed by use of enclosed cams.
2. Finish shall be white baked enamel, unless otherwise specified with a minimum average reflectance of 85% on all exposed and light reflecting surfaces.
3. Housing shall be 22-gauge minimum. Overall depth shall be 4-1/2” minimum. Spacing from bottom of lamp to top of lens shall be 1-7/8” minimum.

2.3 INCANDESCENT FIXTURES

A. Conform to UL 1571.

B. Fixture dimensions shall be proper for the various wattages noted on the plans and as recommended by the fixture manufacturer or as specified.

C. Lamps shall be inside frosted, 120V rated except where otherwise specified. Provide reflector lamps for fixtures designed and cataloged for such lamps unless otherwise specified, 120V rated. Lamps shall be manufactured by General Electric, Osram/Sylvania, or Philips.

D. Recessed incandescent fixtures shall have thermal protection and shall be factory identified as thermally protected, complying fully with NEC 410-65C. Thermal protection must comply with UL #1571. In insulated ceilings, equip each fixture with a field or factory fabricated fireproof box (metal, sheet rock, etc.), complying fully with all clearance requirements and NEC 410-66.

2.4 TRACK LIGHTING SYSTEMS

A. Conform to UL 1574.

B. Provide components, including track, fittings, and fixtures, from same manufacturer and as recommended by manufacturer for intended use.

2.5 HIGH INTENSITY DISCHARGE (HID) FIXTURES

A. Conform to UL 1572.

B. Ballasts shall be electronic (Advance e-Vision, or equal to) suitable for HID.

C. Lamps shall conform to ANSI C78.380. High Pressure Sodium (HPS) lamps shall be clear, and shall have low mercury content, meeting the EPA's Toxic Characteristics Leaching Procedure (TCLP), for disposal as non-hazardous waste. Metal halide lamps shall be phosphor coated indoors, clear outdoors, unless otherwise noted on fixture list.

D. Remote ballasts shall be mounted on heat sink or stand-offs per manufacturer's instructions.

E. Metal Halide lamps shall be in compliance with Oregon State Bill #479. Metal halide lamps shall be self-extinguishing type upon compromise of lamp envelope.

F. Approved Manufacturers: Advance, General Electric, Osram/Sylvania, Venture, Philips.

2.7 OUTDOOR FIXTURES

A. Outdoor fixtures shall be weatherproof, heavy duty types designed for efficient light utilization, adequate dissipation of lamp and ballast heat and safe cleaning and relamping. Ballasts shall be incorporated in the luminaire housings unless otherwise noted. Luminaires shall be sealed unless charcoal filters are provided. Lenses shall be heat and impact resistant, tempered glass. Lens gasket shall be heat and weather resistant. Materials shall be rustproof. Latches and fittings shall be nonferrous metal or stainless steel.

B. Reflectors on HID fixtures shall be secured with lock washers.

C. Set screws on HID fixture reflectors shall be factory furnished in size and quantity to assure that reflector does not vibrate when touched or struck.

2.8 POLES AND STANDARDS

A. Lighting standards, assemblies, and pole bases shall be designed and constructed to withstand a steady wind velocity of 100 miles per hour without permanent distortion or displacement. Where unusual soil or base installation conditions occur, the Contractor shall provide adequate reinforcement under the guidance of the Architect to assure the specified

strength for 100-mile-per-hour wind. Generally poles/bases shall be suitable for installation in earth having an allowable bearing of 1800 pounds per square foot.

2.9 FIXTURES

A. See Drawings for Fixture List.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Lamps of the proper type, wattage, and voltage rating shall be delivered to the project in the original cartons and installed in the fixtures just prior to the completion of the project. Provide lamp type as recommended by the fixture manufacturer.

B. Fixtures shall be left clean at the time of acceptance of the work with every lamp in operation. If fixtures are deemed dirty by the Architect at completion of the project, the Contractor shall clean them.

C. Fixtures shall be carefully aligned, leveled in straight lines, and located as shown on the Architectural reflected ceiling plan. The final decision as to adequacy of support and alignment shall be made by the Architect. The fixtures shall be supported and fastened to the ceiling system.

D. Verify all ceiling conditions and provide all lighting fixtures complete with factory furnished stems, balls, aligners, and canopies as required for a complete installation.

E. All light fixtures installed in suspended ceiling systems shall be positively attached to the ceiling system. In addition, light fixtures shall be supported by #12 gauge steel hanger wires attached to structure. Quantity and location of hanger wires is dependant upon weight of fixture. Refer to IBC Standards for specific requirements.

F. Surface mounted light fixtures shall be securely fastened to the building surface via factory-created holes in the fixtures. Attachment of fixture merely to recessed outlet box is not sufficient.

G. Where two switches are shown dedicated to an office, room, or area, provide two-level lighting.

H. Lighting fixtures in any single enclosed room shall be connected using a common (one) circuit, except in cases where the loading requires a second circuit.

I. Accessories such as straps, mounting plates, nipples, or brackets shall be provided for proper installation.

J. Standards shall be plumb with arms aligned and square. Arms shall be perpendicular to the parking axis unless specifically shown otherwise.

K. Standards shall be in line such that sighting along straight lines of standards will show no standard out of line with the others. The Contractor is cautioned that some curbs or roadway edges may not be straight and, therefore, should not be used for alignment.

L. The Contractor shall erect the luminaires and pole assemblies complete on locations called out on the Drawings.

M. The poles shall be installed with leveling nuts (galvanized). The space between the bottom of the pole base flange and the top of the footing shall be grouted to present a finished appearance with a 1/2” drain hole.

END OF SECTION

PART 1 - GENERAL

1.1 DESCRIPTION

A. The PV Array System is Owner Furnished, Owner Installed. The Owner is contracting this portion of the project directly and will not be part of the Contractor's price. This performance specification is for the purpose of coordination between the general construction of the building and the Owner's PV Contractor and for giving performance guidelines to the PV Contractor.

B. The PV system shall at minimum be a 100.0 KW array output with 480V 3 phase interface with school electrical system, as indicated on the drawings. The PV contractor shall submit to the Architect a full and complete design/build submittal that lists all components of the proposed system and shall include a computer simulation output that demonstrates that the proposed system will meet the above specifications. This specification describes a photovoltaic array, hereafter referred to as the PV. The PV shall feed power into the building power system.

C. The PV shall consist of the components listed in paragraph 2.1 B.

D. The PV system shall meet all the requirements of the state of Oregon House Bill 2620.

1.2 QUALITY ASSURANCE

A. U.L. listed and labeled.

B. Meet NEMA, IEFE, ANSI, OSHA, Oregon Solar Installation Specialty and NEC codes and standards.

C. The manufacturer shall design and install the PV system and shall have a minimum of five years experience in the field. A list of installed PV systems the same type as the manufacturer proposes to furnish for this application shall be supplied with the proposal.

D. The manufacturer shall be certified for the design and installation of the PV system.

E. The installing contractor shall be a "Trade Ally" of the Energy Trust of Oregon.

F. PV contractors shall provide documentation of appropriate licensing and experience to competently install solar photovoltaic systems in the State in which the system is to be installed.

1.3 SUBMITTAL AND RECORD DOCUMENTATION

A. Shop Drawings: Detailing fabrication, internal and interconnecting wiring, and installation of the PV system. Include dimensioned plan, elevation views, and details of control panels. Show access and clearance requirements, ventilation requirements, and weights. Differentiate between field-installed and factory-installed wiring and components, and show field termination locations.

B. Product Data: Include data on features, components, ratings, and performance.

C. Submit Operating and Maintenance Data.

D. Include special project warranties specified in this section.

E. Operation Manual: One copy of the operation manual shall be furnished. It shall possess sufficient detail and clarity to enable the owner's technicians to understand and operate the PV equipment. The manual shall describe the PV system in full by including the following major items:

1. Operating Procedures
2. Performance Data and Technical Data
3. General Description
4. Solar Panel Description
5. Component Description

F. Installation Manual: One copy of the installation manual shall be furnished. It shall possess sufficient detail and clarity to enable the owner's technicians to install the PV equipment. One set of the following drawings and data sheets shall be supplied:

1. Receiving and Installation Instructions
2. PV One-Line Drawings
3. Equipment Outline Drawings
4. Interconnection Drawings
5. Photovoltaic Panels
6. Accessory Wiring Diagrams

1.4 ENVIRONMENTAL REQUIREMENTS

A. The PV inverter(s) shall withstand any combination of the following external environmental conditions without operational degradation.

1. Operating Temperature: 0 degrees C to +40 degrees C (32 degrees F to 104 degrees F) without derating.
2. Relative Humidity (operating): 95% maximum non-condensing.
3. Elevation: 5000 ft (1500 m) maximum at 40 degrees C without derating.

B. Acoustical Noise: Noise generated by the PV equipment under normal operation shall not exceed 65 dbA at one meter from any operator surface, measured at 25 degrees C (77 degrees F) and full load.

C. Input Surge Withstand Capability: The UPS shall be in compliance with ANSI C62.41, Category A & B (6 kV).

1.5 WARRANTY

A. PV System: The PV contractor shall provide a full-system warranty for 2 years, an inverter warranty of 10 years, and photovoltaic module warranty of 20 years or more. A complete system manual shall be provided the client, including warranties, system design documentation, component parts list, and operation/maintenance instructions.

PART 2 - PRODUCTS

2.1 DESIGN REQUIREMENTS

A. Design Requirements

1. The PV contractor shall apply for, arrange, and otherwise secure, on behalf of the client, in advance of the installation, written commitment from all providers of incentives including (as applicable) the Energy Trust of Oregon, the Oregon Department of Energy (BETC for Solar), the Federal Government, any local utility incentive, and other available incentives. Any system installed shall meet the technical and administrative requirements of all incentive providers.
2. There shall be performed a shading analysis on the site proposed for the solar PV collectors. Documentation of the shading factor shall be used in Specification #3 and #5.
3. There shall be performed a photovoltaic system sizing analysis, using PVWatts, or other similar sizing program to determine optimum technical and economic sizing. This analysis shall, including the electricity load from Specification #1, determine the estimated contribution of electricity to be provided by the system, in kilowatt hours and percent of energy.
4. The system, including all component parts, shall be designed and installed in full compliance with Energy Trust of Oregon Solar Electric Technical Requirements, referenced as part of this Specification, as documented on the Energy Trust of Oregon web site: www.energytrust.org, regardless of whether the location is in an Energy Trust of Oregon- served location or not.
5. The solar photovoltaic system shall be installed as designed and according to best practices, and shall meet all applicable codes, particularly electrical and structural.
6. The solar photovoltaic system inverter shall be provided with an auto-disconnect feature that will disconnect the flow of power to the building electrical service upon power loss from the utility side source.

PART 3 - EXECUTION

3.1 INSTALLATION

A. The PV contractor shall install the entire system per the supplier or manufacturers instructions. The equipment supplier shall provide supervision of final installation.

B. The PV contractor shall include all installation charges rendered by the supplier.

C. The PV contractor shall collaborate with the roofing design and/or contractor to assure that the roof and solar mounting systems are fully compatible, and that the roofing attachment system is warranted by the roofing contractor consistent with standard practices.

3.2 TESTING AND SERVICE

A. The PV equipment shall be completely tested and calibrated as a system prior to shipment.

B. The PV contractor shall notify the Owner 30 days before the performance and acceptance tests are to be conducted. A factory trained representative of the manufacturer shall supervise the final testing of the system and it shall be subject to the approval and acceptance of the Owner.

C. Upon completion of the system tests, the certified technician shall submit three copies of a written report on forms provided by the manufacturer to indicate the system has been fully tested and is fully operational conforming to the letter of these specifications. The test report shall contain, but is not limited to the following:

1. A complete list of equipment installed and wired.
2. Indication that all equipment is properly installed.
3. Technician's name, certificate number and date.

D. After completion of all the tests and adjustments listed above, the PV contractor shall submit the following information to the Owner.

1. As-installed conduit layout diagrams including wire color code and tag number.
2. Complete as-installed wiring diagrams.
3. Detailed catalog data on all installed system components.
4. Manufacturers operation and maintenance manuals.
5. Copies of the technician's certified report (as above)
6. Provide the above in bound materials. See Section 16050 of this Specification covering Record information.

3.3 GUARANTEE

A. The PV contractor shall guarantee all equipment and wiring free from inherent mechanical or electrical defects for one year from date of acceptance.

3.4 SERVICE AGREEMENT

A. The manufacturer shall furnish gratis to the Owner a one-year contract effective from date of installation for maintenance and inspection service of the manufacturer's equipment with a minimum of two inspections during the contract year.

3.5 INSTRUCTIONS

A. After the system is complete and all tests are made, the system manufacturer's representative shall instruct the Owner's operating personnel, giving them instructions and information as to the system operation and minor servicing.

B. After installation, the system shall be commissioned by a third party commissioning agent and/or inspected by a third party inspector in addition to the Code inspection.

END OF SECTION

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Furnish and install a local addressable analog fire alarm system as specified herein and as shown on the drawings. All system components shall be of one system manufacturer. All equipment shall be ISO-9000 certified; UL & FM listed and meet NFPA 72.

B. System shall include but not be limited to all controls, power supply, digital communicator, signal initiating and sounding devices, conduit, wiring and all other equipment necessary for a complete and operating system. All equipment shall be American made and assembled.

C. This shall be a non-coded, electrically supervised ,Class A analog addressable fire alarm sytem.

1.2 QUALITY ASSURANCE

A. The system shall comply with the applicable provisions of the National Fire Protection Association Standard Number 70, “National Electrical Code,” Standard Number 72, “National Fire Alarm Code,” and meet all requirements of the local authorities having jurisdiction.

B. All equipment and devices shall be listed by the Underwriters Laboratories, Inc., or approved by Factory Mutual Laboratories and shall meet Federal Specification Standards per the latest edition.

C. All material and equipment shall be the latest standard products of a manufacturer regularly engaged in the manufacture of the products.

D. Equipment shall be represented by a firm with a local service organization that is factory trained and certified. The name of this organization shall be furnished to the Owner.

E. The contractor shall include in the basic bid all installation charges rendered by the supplier.

F. The installing company shall employ NICET (minimum Level II Fire Alarm Technology) technicians on site to guide the final checkout and to ensure the systems integrity.

1.3 SYSTEM OPERATION

A. BASIC SYSTEM FUNCTIONAL OPERATION
When a fire alarm condition is detected and reported by one of the system initiating devices, the following functions shall immediately occur:

1. The system alarm LED on the FACP shall flash.
2. A local piezo electric signal in the control panel shall sound.
3. A backlit 80-character LCD display on the FACP shall indicate all information associated with the fire alarm condition, including the type of alarm point and its location within the protected premises.
4. Printing on the FACP and history storage equipment shall log the information associated each new fire alarm control panel condition, along with time and date of occurrence.
5. All system output programs assigned via control-by-event interlock programming to be activated by the particular point in alarm shall be executed, and the associated system outputs (alarm notification appliances and/or relays) shall be activated.

B. System shall have style 4, class B and style Y class B on the Signaling Line Circuits and Notification Appliance Circuits. Any fault in the circuits shall be annunciated on the display and printed with time, date, location and a list of the system fault(s).

C. The system shall be an active/interrogative type system where each transponder and/or addressable device is repetitively scanned, causing a signal to be transmitted to the main fire alarm control panel (FACP) indicating that the device and its associated circuit wiring is functional. Loss of this signal at the main FACP shall result in a trouble indication as specified hereinafter for the particular input.

1.4 SUBMITTALS

A. General:

1. A minimum of (3) copies (more if directed by architectural documents) of all submittals shall be submitted to the Architect/Engineer for review.
2. All references to manufacturer's model numbers and other pertinent information herein is intended to establish minimum standards of performance, function and quality. Equivalent compatible UL-listed equipment from other manufacturers may be substituted for the specified equipment as long as the minimum standards are met.
3. All substitute equipment proposed as equal to the equipment specified herein, shall meet or exceed the following standards. For equipment other than that specified, the contractor shall supply proof that such substitute equipment equals or exceeds the features, functions, performance, and quality of the specified equipment.

B. Shop Drawings:

1. Sufficient information, clearly presented, shall be included to determine compliance with drawings and specifications.
2. Include manufacturer's name(s), model numbers, ratings, power requirements, equipment layout, device arrangement, complete wiring point-to-point diagrams, and conduit layouts.
3. Show annunciator layout, configurations, and terminations.

C. Manuals:

1. Submit simultaneously with the shop drawings, complete operating and maintenance manuals listing the manufacturer's name(s), including technical data sheets.
2. Wiring diagrams shall indicate internal wiring for each device and the interconnections between the items of equipment.
3. Provide a clear and concise description of operation that gives, in detail, the information required to properly operate the equipment and system.
4. Approvals will be based on complete submissions of manuals together with shop drawings.

D. Software Modifications

1. Provide the services of a factory trained and authorized technician to perform all system software installations, modifications, upgrades or changes. Response time of the technician to the site shall not exceed 4 hours.
2. Provide all hardware, software, programming tools and documentation necessary to modify the fire alarm system on site. Modification includes addition and deletion of devices, circuits, zones and changes to system operation and custom label changes for devices or zones. The system structure and software shall place no limit on the type or extent of software modifications on-site. Modification of software shall not require power-down of the system or loss of system fire protection while modifications are being made.

E. Certifications: Together with the shop drawing submittal, submit a certification from the major equipment manufacturer indicating that the proposed supervisor of the installation and the proposed performer of contract maintenance is an authorized representative of the major equipment manufacturer. Include names and addresses in the certification.

F. Fire alarm documents are to be submitted together for review.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Silent Knight is the district approved manufacturer.

B. Documentation from the manufacturer shall be presented to the Architect and Engineer certifying that the persons making the final connections, system programming, check-out and providing the warranty are factory trained technicians in the employ of the factory authorized representative.

2.2 MAIN FIRE ALARM CONTROL PANEL:

A. The FACP shall contain a microprocessor based Central Processing Unit (CPU). The CPU shall communicate with and control the following types of equipment used to make up the system: intelligent addressable smoke and thermal (heat) detectors, addressable modules, printer, annunciators, and other system controlled devices.

B. Operator Control:

1. Acknowledge Switch:
   a. Activation of the control panel acknowledge switch in response to new alarms and/or troubles shall silence the local panel piezo electric signal and change the alarm and trouble LEDs from flashing mode to steady-ON mode. If multiple alarm or trouble conditions exist, depression of this switch shall advance the 80-character LCD display to the next alarm or trouble condition.
   b. Depression of the Acknowledge switch shall also silence all remote annunciator piezo sounders.
2. Alarm Silence Switch: Activation of the alarm silence switch shall cause all programmed alarm notification appliances and relays to return to the normal condition after an alarm condition. The selection of notification circuits and relays that can be silenced by this switch shall be fully field programmable within the confines of all applicable standards. The FACP software shall include silence inhibit and auto-silence timers.
3. Alarm Activate (Drill) Switch: The Alarm Activate switch shall activate all notification appliance circuits. The drill function shall latch until the panel is silenced or reset.
4. System Reset Switch: Activation of the System Reset switch shall cause all electronically-latched initiating devices, appliances or software zones, as well as all associated output devices and circuits, to return to their normal condition.
5. Lamp Test: The Lamp Test switch shall activate all system LEDs and light each segment of the liquid crystal display.

C. System Capacity and General Operation:

1. The control panel shall provide, or be capable of expansion to 396 intelligent/addressable devices.

2. The control panel shall include Form-C alarm, trouble, supervisory, and security relays rated at a minimum of 3.0 amps @ 30 VDC. It shall also include four Class B (NFPA Style Y) or Class A (NFPA Style Z) programmable Notification Appliance Circuits.
3. The system shall support up to 8 additional output modules (signal, speaker, telephone, or relay), each with 8 circuits for an additional 64 circuits. These circuits shall be either Class A (NFPA Style D) or Class B (NFPA Style Y) per the project drawings.
4. The fire alarm control panel shall include a full featured operator interface control and annunciation panel that shall include a backlit Liquid Crystal Display (LCD), individual color-coded system status LEDs, and an alphanumeric keypad for the field programming and control of the fire alarm system.
5. The FACP shall provide the following features:
    a. Drift compensation to extend detector accuracy over life. Drift compensation shall also include a smoothing feature, allowing transient noise signals to be filtered out.
    b. Detector sensitivity test, meeting requirements of NFPA 72, Chapter 7.
    c. Maintenance alert, with two levels (maintenance alert/maintenance urgent), to warn of excessive smoke detector dirt or dust accumulation.
    d. Nine sensitivity levels for alarm, selected by detector. The alarm level range shall be 1 to 2.35 percent per foot for photoelectric detectors and 0.5 to 2.5 percent per foot for ionization detectors. The system shall also include up to nine levels of prealarm, selected by detector, to indicate to maintenance personnel of impending alarms.
    e. The ability to display or print system reports.
    f. Alarm verification, with counters and a trouble indication to alert maintenance personnel when a detector enters verification 20 times.
    g. PAS presignal, meeting NFPA 72 3-8.3 requirements.
    h. Rapid manual station reporting (under 3 seconds).
    i. Non-alarm points for general (non-fire) control.
    j. Periodic detector test, conducted automatically by the software.
    k. Self optimizing pre-alarm for advanced fire warning, which allows each detector to learn its particular environment and set its prealarm level to just above normal peaks.
    l. Cross zoning with the capability of counting: two detectors in alarm, two software zones in alarm, or one smoke detector and one thermal detector.
    m. Walk test, with a check for two detectors set to same address.
    n. Control-by-time for non-fire operations, with holiday schedules.
    o. Day/night automatic adjustment of detector sensitivity.
    p. Device blink control for sleeping areas.
    q. UL-1076 security monitor points.
    r. Releasing options including: 10 independent hazards, a sophisticated cross-zone, delay and discharge timers, and an abort function. The system shall also include the ability to control low pressure CO2 valves with the ability to set time in/time out values in one second increments including a soak time of up to 9999 seconds.
    s. Releasing options including: 10 independent hazards, a sophisticated cross-zone, delay and discharge timers, and an abort function. The system shall also include the ability to control low pressure CO2 valves with the ability to set time in/time out values in one second increments including a soak time of up to 9999 seconds.

6. The FACP shall be capable of coding notification circuits in march time (120 PPM), temporal (NFPA 72 A-2-2.2.2), and California code. Main panel notification circuits (NAC 1,2,3 and 4) shall also support special two and three stage operations. The two stage feature allows 20 Pulses Per Minute (PPM) on alarm and 120 PPM after 5 minutes or when a second device activates. The three-stage option provides 20 PPM with one detector in alarm, 120 PPM with two detectors in alarm, and steady on with release.

D. Central Microprocessor:

1. The microprocessor shall be a state-of-the-art, high speed, 16 bit RISC device and it shall communicate with, monitor and control all external interfaces. It shall include an EPROM for system program storage, non-volatile memory for building-specific program storage, and a "watch dog" timer circuit to detect and report microprocessor failure.
2. The microprocessor shall contain and execute all control-by-event programs for specific action to be taken if an alarm condition is detected by the system. Control-by-event equations shall be held in non-volatile programmable memory, and shall not be lost even if system primary and secondary power failure occurs.
3. The microprocessor shall also provide a real-time clock for time annotation of system displays, printer, and history file. The time-of-day and date shall not be lost if system primary and secondary power supplies fail. The real time clock may also be used to control non-fire functions at programmed time-of-day, day-of-week, and day-of-year.
4. A special program check function shall be provided to detect common operator errors.
5. An auto-program (self-learn) function shall be provided to quickly install initial functions and make the system operational.
6. For flexibility and to ensure program validity, an optional Windows(TM) based program utility shall be available. This program shall be used to off-line program the system with batch upload/download. This program shall also have a verification utility, which scans the program files, identifying possible errors. It shall also have the ability to compare old program files to new ones, identifying differences in the two files to allow complete testing of any system operating changes. This shall be in incompliance with the NFPA 72 requirements for testing after system modification.

E. Display:

1. The display shall provide all the controls and indicators used by the system operator and may also be used to program all system operational parameters.
2. The display shall include status information and custom alphanumeric labels for all intelligent detectors, addressable modules, internal panel circuits, and software zones.
3. The display shall include an 80-character backlit alphanumeric Liquid Crystal Display (LCD). It shall also provide 8 Light-Emitting-Diodes (LEDs), that indicate the status of the following system parameters: AC POWER, FIRE ALARM, PREALARM WARNING, SECURITY ALARM, SUPERVISORY SIGNAL, SYSTEM TROUBLE, DISABLED POINTS, and ALARM SILENCED.
4. The display keypad shall be an easy to use QWERTY type keypad, similar to a PC keyboard. This shall be part of the standard system and have the capability to command all system functions, entry of any alphabetic or numeric information, and field programming. Two different password levels shall be provided to prevent unauthorized system control or programming.
5. The display shall include the following operator control switches: ACKNOWLEDGE, ALARM SILENCE, ALARM ACTIVATE (drill), SYSTEM RESET, and LAMP TEST.
6. The system shall support an optional battery ammeter/voltmeter display.

F. Signaling Line Circuits (SLC):

1. The system shall include two SLCs. Each SLC interface shall provide power to and communicate with up to 99 intelligent detectors (ionization, photoelectric or thermal) and 99 intelligent modules (monitor or control) for a system capacity of 396 devices. Each SLC shall be capable of NFPA 72 Style 4, Style 6, or Style 7 (Class A or B) wiring.
2. The Loop Interface Board (LIB) shall receive analog information from all intelligent detectors to be processed to determine whether normal, alarm, prealarm, or trouble conditions exist for each detector. The software shall automatically maintain the detector's desired sensitivity level by adjusting for the effects of environmental factors, including the accumulation of dust in each detector. The analog information shall also be used for automatic detector testing and for the automatic determination of detector maintenance requirements.

3. The detector software shall meet NFPA 72, Chapter 7 requirements and be certified by UL as a calibrated sensitivity test instrument.
4. The detector software shall allow manual or automatic sensitivity adjustment.

G. Serial Interfaces:

1. The system shall include two serial EIA-232 interfaces. Each interface shall be a means of connecting UL Listed Electronic Data Processing (EDP) peripherals.
2. One EIA-232 interface shall be used to connect an UL-Listed 40 or 80-column printer. Printers, which are not UL-Listed, are not considered acceptable substitutes.
3. One EIA-232 interface shall be used to connect an UL-Listed 40 or 80-column printer. Printers, which are not UL-Listed, are not considered acceptable substitutes.
4. The second EIA-232 interface shall be used to connect an UL-listed CRT terminal. This interface shall include special protocol methods that allow off-site monitoring of the FACP over standard dial-up phone lines. This ancillary capability shall allow remote readout of all status information, including analog values, and shall not interfere with or degrade FACP operations when used. It shall allow remote FACP Acknowledge, Reset, or Signal Silence in this mode. It shall also allow adjustment of detector sensitivity and readout of the history file.
5. The system shall include an EIA-485 port for the serial connection of optional annunciators and remote LCD displays.
6. The EIA-485 interface may be used for network connection to a proprietary receiving unit.

H. Notification Appliance Circuit (NAC) Module:

1. The Notification Appliance Circuit module shall provide four fully supervised Class A or B (NFPA Style Z or Y) notification circuits. An expansion circuit board shall allow expansion to eight circuits per module.
2. The notification circuit capacity shall be 3.0 amperes maximum per circuit and 6.0 amperes maximum per module.
3. The module shall not affect other module circuits in any way during a short circuit condition.
4. The module shall provide eight green ON/OFF LEDs and eight yellow TROUBLE LEDs.
5. The module shall also provide a momentary switch per circuit that may be used to manually turn the particular circuit on or off or to disable the circuit.
6. Each notification circuit shall include a custom label inserted to identify each circuit’s location. Labels shall be created using a standard typewriter or word processor.
7. The notification circuit module shall be provided with removable wiring terminal blocks for ease of installation and service. The terminal strips shall be UL listed for use with up to 12 AWG wire.
8. Each circuit shall be capable of, through system programming, deactivating upon depression of the signal silence switch.

I. Control Relay Module:

1. The control relay module shall provide four Form-C auxiliary relay circuits rated at 5 amperes, 28 VDC. An expansion circuit board shall allow expansion to eight Form-C relays per module.
2. Each relay circuit shall be capable of being activated (change in state) by any initiating device or from any combination of initiating devices.
3. The expansion module shall provide 8 green ON/OFF LEDs and 8 yellow LEDs (indicates disabled status of the relay).
4. The module shall provide a momentary switch per relay circuit that may be used to manually turn the relay ON/OFF or to disable the relay.
5. Each relay circuit shall include a custom label inserted to identify its location. Labels shall be created using a standard typewriter or word processor.

6. The control relay module shall be provided with removable wiring terminal blocks for ease of installation and service. The terminal blocks shall be UL listed for use with up to 12 AWG wire.

J. Field Programming:

1. The system shall be programmable, configurable and expandable in the field.
2. It shall be possible to program through the standard FACP keyboard all system functions.
3. All field defined programs shall be stored in non-volatile memory.
4. Two levels of password protection shall be provided in addition to a key-lock cabinet. One level shall be used for status level changes such as point/zone disable or manual on/off commands (Building Manager). A second (higher-level) shall be used for actual change of the life safety program (installer). These passwords shall be five (5) digits at a minimum. Upon entry of an invalid password for the third time within a one-minute time period an encrypted number shall be displayed. This number can be used as a reference for determining a forgotten password.
5. The system programming shall be "backed" up on a 3.5" floppy diskette utilizing an upload/download program. This system back-up disk shall be completed and given in duplicate to the building owner and/or operator upon completion of the final inspection. The program that performs this function shall be "non-proprietary", in that, it shall be possible to forward it to the building owner/operator upon his or her request.
6. Programmed control point activation shall include selective control of HVAC, door holder release, elevator recall, elevator power module shunt-trip, fire pump control, stairwell pressurization fans, etc.

K. Power Supply:

1. The main power supply for the fire alarm control panel shall provide 6.0 amps of available power for the control panel and peripheral devices.
2. Provisions will be made to allow the audio-visual power to be increased as required by adding modular expansion audio-visual power supplies.
3. Positive-Temperature-Coefficient (PTC) thermistors, circuit breakers, or other over-current protection shall be provided on all power outputs. The power supply shall provide an integral battery charger for use with batteries up to 60 AH or may be used with an external battery and charger systems. Battery arrangement may be configured in the field.
4. The main power supply shall continuously monitor all field wires for earth ground conditions, and shall have the following LED indicators:
   a. Ground Fault LED
   b. Battery Fail LED
   c. AC Power Fail LED
5. The main power supply shall operate on 120 VAC, 60 Hz, and shall provide all necessary power for the FACP.
6. The main power supply shall provide a battery charger for 24 hours of standby using dual-rate charging techniques for fast battery recharge.
7. The main power supply shall provide a very low frequency sweep earth detect circuit, capable of detecting earth faults.
8. The main power supply shall provide meters to indicate battery voltage and charging current.

L. Auxiliary Field Power Supply – Addressable:

1. The auxiliary addressable power supply is a remote 24 VDC power supply used to power Notification Devices and field devices that require regulated 24VDC power. The power supply shall also include and charge backup batteries.
2. The addressable power supply for the fire alarm system shall provide up a minimum of 6.0 amps of 24 volt DC regulated power for Notification Appliance Circuit (NAC) power or 5

amps of 24 volt DC general power. The power supply shall have an additional .5 amp of 24 VDC auxiliary power for use within the same cabinet as the power supply. It shall include an integral charger designed to charge 7.0 - 25.0 amp hour batteries.

3. The addressable power supply shall provide four individually addressable Notification Appliance Circuits that may be configured as two Class "A" and two Class "B" or four Class "B" only circuits. All circuits shall be power-limited per UL 864 requirements.
4. The addressable power supply shall provide built-in synchronization for certain Notification Appliances on each circuit without the need for additional synchronization modules. The power supply's output circuits shall be individually selected for synchronization. A single addressable power supply shall be capable of supporting both synchronized and non-synchronized Notification Devices at the same time.
5. The addressable power supply shall operate on 120 or 240 VAC, 50/60 Hz.
6. The interface to the power supply from the Fire Alarm Control Panel (FACP) shall be via the Signaling Line Circuit (SLC) or other multiplexed means Power supplies that do not use an intelligent interface are not suitable substitutes. The required wiring from the FACP to the addressable power supply shall be a single unshielded twisted pair wire. Data on the SLC shall be transmitted between 24 VDC, 5 VDC and 0 VDC at approximately 3.33k baud.
7. The addressable power supply shall supervise for battery charging failure, AC power loss, power brownout, battery failure, NAC loss, and optional ground fault detection. In the event of a trouble condition, the addressable power supply shall report the incident and the applicable address to the FACP via the SLC.
8. The addressable power supply shall have an AC Power Loss Delay option. If this option is utilized and the addressable power supply experiences an AC power loss, reporting of the incident to the FACP will be delayed. A delay time of eight or sixteen hours shall be Dip-switch selected.
9. The addressable power supply shall have an option for Canadian Trouble Reporting and this option shall be Dip-switch selectable.
10. The addressable power supply mounts in either the FACP backbox or it's own dedicated surface mounted backbox with cover.
11. Each of the power supply's four output circuits shall be DIP-switch selected for Notification Appliance Circuit or General Purpose 24 VDC power. Any output circuit shall be able to provide up to 2.5 amps of 24 VDC power.
12. The addressable power supply's output circuits shall be individually supervised when they are selected to be either a Notification Appliance Circuit when wired Class "A" or by the use of and end-of-line resistor. When the power supply's output circuit is selected as General 24VDC power, the circuit shall be individually supervised when an end-of-line relay is used.
13. When selected for Notification Appliance Circuits, the output circuits shall be individually DIP-switch selectable for Steady, March Time, Dual Stage or Temporal.
14. When selected as a Notification Appliance Circuit, the output circuits of the addressable power supply shall have the option to be coded by the use of a universal zone coder.
15. The addressable power supply shall interface and synchronize with other power supplies of the same type. The required wiring to interface multiple addressable power supplies shall be a single unshielded, twisted pair wire.
16. An individual or multiple interfaced addressable power supplies shall have the option to use an external charger for battery charging. Interfaced power supplies shall have the option to share backup battery power.

M. Field Charging Power Supply: The FCPS is a device designed for use as either a remote 24 volt power supply or used to power Notification Appliances.

1. The FCPS shall offer up to 6.0 amps (4.0 amps continuous) of regulated 24-volt power. It shall include an integral charger designed to charge 7.0 amp hour batteries and to support 60-hour standby.

2. The Field Charging Power Supply shall have two input triggers. The input trigger shall be a Notification Appliance Circuit (from the fire alarm control panel) or a relay. Four outputs (two Style Y or Z and two style Y) shall be available for connection to the Notification devices.
3. The FCPS shall include an attractive surface mount backbox.
4. The Field Charging Power Supply shall include the ability to delay the AC fail delay per 1993 NFPA requirements.
5. The FCPS include power limited circuitry, per 1995 UL standards.

2.3 ANNUNCIATORS

A. Alphanumeric LCD Type Annunciator:

1. The alphanumeric display annunciator shall be a supervised, remotely located backlit LCD display containing a minimum of eighty (80) characters for alarm annunciation in clear English text.
2. The LCD annunciator shall display all alarm and trouble conditions in the system.
3. An audible indication of alarm shall be integral to the alphanumeric display.
4. The display shall be UL listed for fire alarm application.
5. It shall be possible to connect up to 32 LCD displays and be capable of wiring distances up to 6,000 feet from the control panel.
6. The annunciator shall connect to a separate, dedicated "terminal mode" EIA-485 interface. This is a two-wire loop connection and shall be capable of distances to 6,000 feet. Each terminal mode LCD display shall mimic the main control panel.
7. The system shall allow a minimum of 32 terminal mode LCD annunciators. Up to 10 LCD annunciators shall be capable of the following system functions: Acknowledge, Signal Silence and Reset, which shall be protected from unauthorized use by a key switch or password.
8. The LED annunciator shall offer an interface to a graphic style annunciator and provide each of the features listed above.

2.4 SYSTEM COMPONENTS - ADDRESSABLE DEVICES

A. Addressable Devices – General:

1. Addressable devices shall use simple to install and maintain decade (numbered 0 to 9) type address switches.
2. Addressable devices, which use a binary-coded address setting method, such as a DIP switch, are not an allowable substitute.
3. Detectors shall be intelligent (analog) and addressable, and shall connect with two wires to the fire alarm control panel signaling line circuits. Detectors shall be supplied with dual auxiliary contacts for connection to air handlers, elevator controls, and other systems as required.
4. Addressable smoke and thermal detectors shall provide dual alarm and power/polling LEDs. Both LEDs shall flash under normal conditions, indicating that the detector is operational and in regular communication with the control panel, and both LEDs shall be placed into steady illumination by the control panel, indicating that an alarm condition has been detected. If required, the LED flash shall have the ability to be removed from the system program. An output connection shall also be provided in the base to connect an external remote alarm LED.
5. The fire alarm control panel shall permit detector sensitivity adjustment through field programming of the system. The panel on a time-of-day basis shall automatically adjust sensitivity.
6. Using software in the FACP, detectors shall automatically compensate for dust accumulation and other slow environmental changes that may affect their performance.

The detectors shall be listed by UL as meeting the calibrated sensitivity test requirements of NFPA Standard 72, Chapter 7.

7. The detectors shall be ceiling-mount and shall include a separate twist-lock base with tamper proof feature. Base shall include a sounder base with a built-in (local) sounder rated at 85 DBA minimum, a relay base and an isolator base designed for Style 7 applications.
8. The detectors shall provide a test means whereby they will simulate an alarm condition and report that condition to the control panel. Such a test may be initiated at the detector itself (by activating a magnetic switch) or initiated remotely on command from the control panel.
9. Detectors shall also store an internal identifying type code that the control panel shall use to identify the type of device (ION, PHOTO, THERMAL).
10. Detectors will operate in an analog fashion, where the detector simply measures its designed environment variable and transmits an analog value to the FACP based on real-time measured values. The FACP software, not the detector, shall make the alarm/normal decision, thereby allowing the sensitivity of each detector to be set in the FACP program and allowing the system operator to view the current analog value of each detector.
11. Detectors shall provide address-setting means using decimal switches and shall also store an internal identifying code that the control panel shall use to identify the type of device. LEDs shall be provided that shall flash under normal conditions, indicating that the device is operational and is in regular communication with the control panel.
12. Addressable devices shall provide address-setting means using decimal switches and shall also store an internal identifying code that the control panel shall use to identify the type of device. LED(s) shall be provided that shall flash under normal conditions, indicating that the device is operational and is in regular communication with the control panel.
13. A magnetic test switch shall be provided to test detectors and modules. Detectors shall report an indication of an analog value reaching 100% of the alarm threshold.

B. Addressable Pull Box (Manual Station):

1. Addressable pull boxes shall, on command from the control panel, send data to the panel representing the state of the manual switch and the addressable communication module status. They shall use a key operated test-reset lock, and shall be designed so that after actual emergency operation, they cannot be restored to normal use except by the use of a key.
2. All operated stations shall have a positive, visual indication of operation and utilize a key type reset.
3. Manual stations shall be constructed of Lexan with clearly visible operating instructions provided on the cover. The word FIRE shall appear on the front of the stations in raised letters, 1.75 inches (44 mm) or larger.

C. Intelligent Photoelectric Smoke Detector: The detectors shall use the photoelectric (light-scattering) principal to measure smoke density and shall, on command from the control panel, send data to the panel representing the analog level of smoke density.

D. Intelligent Thermal Detectors: Thermal detectors shall be intelligent addressable devices rated at 135 deg. F (58 degrees C) and have a rate-of-rise element rated at 15 deg. F (9.4 degrees C) per minute. It shall connect via two wires to the fire alarm control panel signaling line circuit.

E. Duct Smoke Sensor: The detector is to be Photoelectric type.

1. If possible the detector and housing will be a one-piece design. The housing and detector separate is allowed if a one-piece unit is not available.
   a. The duct detector housing shall be supplied with a clear cover so the presence of smoke can be monitored.

b. Shall be supplied with either a magnetic test feature or an injection tube for device testing.
c. Designed to operate with air velocity in the range of 300-4000fpm.
d. Coordinate with mechanical plans for duct size and provide the appropriate length of sampling tubes.
e. For maintenance purposes, it shall be possible to clean the duct housing sampling tubes by accessing them through the duct housing front cover.

2. Detectors of either design will be provided with relays to connect to the fire alarm panel, DDC panel, as well as connect to a remote status LED.
3. Remote status LED will display the detector status exactly the same as the detector. The remote status LED is to indicate the detector is operational, in trouble mode, or in alarm.
   a. The remote status LED is required if the duct detector is over 10’ off the finished floor or is not visible because of a drop ceiling.
   b. Verify exact location to mount the remote status LED with the local AHJ prior to installation.

F. Addressable Dry Contact Monitor Module

1. Addressable monitor modules shall be provided to connect one supervised IDC zone of conventional alarm initiating devices (any N.O. dry contact device) to one of the fire alarm control panel SLCs.
2. The monitor module shall mount in a 4-inch square (101.6 mm square), 2-1/8 inch (54 mm) deep electrical box.
3. The IDC zone shall be suitable for Style D or Style B operation. An LED shall be provided that shall flash under normal conditions, indicating that the monitor module is operational and in regular communication with the control panel.
4. For difficult to reach areas, the monitor module shall be available in a miniature package and shall be no larger than 2-3/4 inch (70 mm) x 1-1/4 inch (31.7 mm) x 1/2 inch (12.7 mm). This version need not include Style D or an LED.

G. Two-Wire Detector Monitor Module:

1. Addressable monitor modules shall be provided to connect one supervised IDC zone of conventional 2-wire smoke detectors or alarm initiating devices (any N.O. dry contact device).
2. The two-wire monitor module shall mount in a 4-inch square (101.6 mm square), 2-1/8 inch (54 mm) deep electrical box or with an optional surface backbox.
3. The IDC zone may be wired for Class A or B (Style D or Style B) operation. An LED shall be provided that shall flash under normal conditions, indicating that the monitor module is operational and in regular communication with the control panel.

H. Addressable Control Module:

1. Addressable control modules shall be provided to supervise and control the operation of one conventional NACs of compatible, 24 VDC powered, polarized audio/visual notification appliances. For fan shutdown and other auxiliary control functions, the control module may be set to operate as a dry contract relay.
2. The control module shall mount in a standard 4-inch square, 2-1/8 inch deep electrical box, or to a surface mounted backbox.
3. The control module NAC may be wired for Style Z or Style Y (Class A/B) with up to 1 amp of inductive A/V signal, or 2 amps of resistive A/V signal operation, or as a dry contact (Form-C) relay. The relay coil shall be magnetically latched to reduce wiring connection requirements, and to insure that 100% of all auxiliary relay or NACs may be energized at the same time on the same pair of wires.
4. Audio/visual power shall be provided by a separate supervised power circuit from the main fire alarm control panel or from a supervised, UL listed remote power supply.

5. The control module shall be suitable for pilot duty applications and rated for a minimum of 0.6 amps at 30 VDC.

I. Addressable Relay Module: Addressable Relay Modules shall be available for HVAC control and other building functions. The relay shall be form C and rated for a minimum of 2.0 Amps resistive or 1.0 Amps inductive. The relay coil shall be magnetically latched to reduce wiring connection requirements, and to insure that 100% of all auxiliary relay or NACs may be energized at the same time on the same pair of wires.

2.5 ALARM INDICATING DEVICES

A. Horns shall be of sufficient number so that an alarm shall be clearly audible to all occupants of the building and/or fire area, as required by these specifications. Wall mounted devices shall be mounted in such a way that the lens is not less than 80” and not greater than 96” above the finished floor. Locations where ceilings prevent the installation at 96" centerline, the centerline of the unit shall be 6" below the ceiling.

B. Audible alarm signals shall produce a sound level at least 15 dBA above the average ambient sound level or 5 dBA above the maximum sound level having a duration of a least 60 seconds (whichever is greater) measured 5 feet above the floor in each occupied area. The average ambient sound level is the root mean square, a weighted sound pressure measured over a 24-hour period.

C. Strobes shall be installed as shown on the drawings in accordance with the requirements of the UL 1971 standard and NFPA 72. Where multiple visual notification appliances can be seen from any location, circuitry shall be incorporated for the synchronization of flash rate.
1. Strobes shall produce a flash rate of one (1) flash per second minimum over the listed input voltage (20VDC - 31VDC) range.
2. Strobes shall incorporate a Xenon flashtube enclosed in a rugged Lexan lens or equivalent with solid-state circuitry.
3. Strobe intensity shall be rated per UL 1971 for 15/75, 30/75, 60/75, 75 or 110 Candela. Dual listing strobes of 15/75 intensity for UL 1971/near-axis requirements shall be used where acceptable.
4. Strobes shall be available for semi-flush or surface mounting and in conjunction with audible appliances as required.

D. Provide manufacturer’s standard wireguard where so indicated on the Drawings.

2.6 CONDUIT AND WIRE

A. Conduit:

1. Conduit shall be in accordance with The National Electrical Code (NEC), local and state requirements.
2. Where required, all wiring shall be installed in conduit or raceway. Conduit fill shall not exceed 40 percent of interior cross sectional area where three or more cables are contained within a single conduit.
3. Cable must be separated from any open conductors of power, or Class 1 circuits, and shall not be placed in any conduit, junction box or raceway containing these conductors, per NEC Article 760-29.
4. Wiring for 24 volt DC control, alarm notification, emergency communication and similar power-limited auxiliary functions may be run in the same conduit as initiating and signaling line circuits. All circuits shall be provided with transient suppression devices and the system shall be designed to permit simultaneous operation of all circuits without interference or loss of signals.

5. Conduit shall not enter the fire alarm control panel, or any other remotely mounted control panel equipment or backboxes, except where conduit entry is specified by the FACP manufacturer.
6. Conduit shall be 3/4 inch (19.1 mm) minimum.

B. Wire:

1. All fire alarm system wiring shall be new.
2. Wiring shall be in accordance with local, state and national codes (e.g., NEC Article 760) and as recommended by the manufacturer of the fire alarm system. Number and size of conductors shall be as recommended by the fire alarm system manufacturer, but not less than 18 AWG (1.02 mm) for Initiating Device Circuits and Signaling Line Circuits, and 14 AWG (1.63 mm) for Notification Appliance Circuits.
3. All wire and cable shall be listed and/or approved by a recognized testing agency for use with a protective signaling system.
4. Wire and cable not installed in conduit shall have a fire resistance rating suitable for the installation as indicated in NFPA 70 (e.g., FPLR).
5. Wiring used for the multiplex communication circuit (SLC) shall be twisted and shielded and support a minimum wiring distance of 10,000 feet. In certain applications, the system shall support up to 2 SLCs with up to 1,000 feet of untwisted, unshielded wire. The design of the system shall permit use of IDC and NAC wiring in the same conduit with the SLC communication circuit.

C. Terminal Boxes, Junction Boxes and Cabinets: All boxes and cabinets shall be UL listed for their use and purpose.

PART 3 - EXECUTION

3.1 OPERATION

A. The fire alarm components (i.e. pull stations, smoke detectors, photoelectric smoke detectors, horns, magnetic door holders, fire alarm panel, batteries, chargers, fire alarm cable, etc.) will be supplied, installed and connected by Division 16 Contract Work. Duct smoke detectors are to be installed by Division 15, supplied and wired by Division 16.

B. The fire alarm system operation subsequent to the alarm activation of any pull station or automatic detection device shall be as follows:

1. Sound the building audible alarm devices.
2. Display on the control panel the English language description of the alarm and its location.
3. Print on the printer the alarm type, location, time and date.
4. Activate programmed output modules points.
5. Report the condition to the central station.
6. Log in the event buffer all system activity.
7. Recall the elevator if the alarm is activated from the lobby smoke detector(s).
8. Release magnetically held fire doors.
9. Deactivate the 120 volt smoke damper circuits.
10. Operate the elevator power module shunt trip switch to disconnect elevator power if the alarm is activated from the elevator heat detector(s).

C. Zoning: Provide each initiating device with its own address. This includes all detectors, pull stations, sprinkler flow switches, tamper switches, low air switches and any other monitored point.

3.2 INSTALLATION

A. Boxes, Enclosures and Wiring Devices:

1. Boxes shall be installed plumb and firmly in position.
2. Extension rings with blank covers shall be installed on junction boxes where required.
3. Junction boxes served by concealed conduit shall be flush mounted.
4. Upon initial installation, all wiring outlets, junction, pull and outlet boxes shall have dust covers. Dust covers shall not be removed until wiring installation when permanent dust covers or devices are installed.
5. All junction box covers shall be painted fire department red and be affixed with a decal or silk-screened label “Fire Alarm System.”
6. Wet or damp locations shall require a NEMA rated enclosure suitable for the environment in which an addressable field device or module are to be installed. (i.e. monitoring of sprinkler water flow, tamper switches and OS&Y valves)
7. Termination junction boxes shall be of adequate size and room to facilitate ease of accessibility to work on wiring and to provide ample space for proper identification labeling. Enclosure design shall incorporate the use of a back plate within the enclosure to provide ease of installation. Terminal blocks shall be affixed to a secured mounting rail. Terminal enclosures shall be painted fire department red and stenciled “Interior Fire Alarm System.”
8. Electrical conduits shall enter only at the side or the bottom of control cabinets, unless designed and approved for entry on the top.
9. All conduits shall be grounded to a water main by approved ground clamps with a conductor equal in size to the largest conductor used in the system; but in no case shall the ground conductor be smaller than no. 10 AWG.

B. Conductors:

1. Each conductor shall be identified as shown on the drawings at each with wire markers at terminal points. Attach permanent wire markers within 2 inches of the wire termination. Marker legends shall be visible.
2. All wiring shall be supplied and installed in compliance with the requirements of the National Electric Code, NFPA 70, Article 760, and that of the manufacturer-wiring guides.
3. Wiring in accessible locations (i.e. above removable ceiling tiles) may be open fire alarm cable. The cabling is to be supported off the ceiling grid by means of D-rings, J-Hooks, or other products manufactured for the purpose. The cable is to be supported at least every 5’ and will not share a cable path with any other system. Cable shall not be attached to conduit, pipe, or ceiling stringers used by any other trade.
4. Wiring in inaccessible locations (i.e. walls, above gyp ceilings) shall be in a conduit raceway system. The contractor has the option to re-use the existing fire alarm raceway system if applicable and found to be in good condition. All conductors installed in existing raceway shall be THHN. Verify wiring with equipment supplier and increase conduit size where required.
5. Wiring for analog loop circuits, conventional detection circuits, speaker circuits and telephone circuits shall based on the fire alarm manufactures wiring guidelines, but shall not be smaller than #18 AWG.
6. Splices shall be made with UL listed wire nuts of the appropriate size for the cable gauge and count.
7. Crimp-on type spade lugs shall be used for terminations of stranded conductors to binder screw or stud type terminals. Spade lugs shall have upset legs and insulation sleeves sized for the conductors.
8. A consistent color code for fire alarm system conductors throughout the installation shall be provided. The installation contractor shall submit for approval prior to installation of wire, a proposed color code for system conductors to allow rapid identification of circuit types.

9. All nominal voltage branch circuit power feeds (120/220 VAC) shall be identified “labeled” at both ends of the circuit to indicate its source and purpose.
10. Wiring within system control panels shall be arranged and routed to allow accessibility to equipment for adjustment and maintenance and to isolate nominal voltage wiring from system low voltage wiring.
11. Splices in electrical conductors in vertical risers are prohibited.
12. Initiating circuits shall be arranged to serve like categories (manual, smoke, waterflow). Mixed category circuitry shall not be permitted except on signaling line circuits connected to intelligent reporting devices.
13. Communication circuits give off RF noise. Maintain at least an eighteen-inch distance from all other communication circuits, where possible.

3.3 FIELD QUALITY CONTROL

A. Certificate of Compliance: Complete and submit to the project engineer in accordance with NFPA 72, paragraph 1.7.2.

B. Field-Testing General:

1. Prior to any testing or programming verify numbering scheme, room names, and other means of identifying addressable devices prior to testing and labeling. The owner will be given a minimum of one week notice prior to the contractor requiring to have the numbering scheme requested by the owner.
2. Each addressable analog smoke detector shall be individually field tested prior to installing the device at its designated location to ensure reliability after shipment and storage conditions. A dated log indicating correct address, type of device, sensitivity and initials of the technician performing test - using test equipment specifically designed for that purpose - shall be prepared and kept for final acceptance documentation. After testing, the detection devices and base shall be labeled with the system address, date and initials of installing technician. Labeling shall not be visible after installation is complete.
3. Wiring runs shall be tested for continuity, short circuits and grounds before system is energized. Tests shall check for stray voltage not to exceed 1 volt AC/DC unless otherwise specified by the manufacturer. Resistance, current and voltage readings shall be made as work progresses.
4. All test equipment, instruments, tools and labor required to conduct the system tests shall be made available by the installing contractor.
5. In addition to the testing specified to be performed by the installing contractor, the installation shall be subject to test by the acceptance inspector.

C. Final Acceptance Testing:

1. Testing shall be in accordance with NFPA72 and this specification.
2. A final As-built Function Matrix shall be prepared by the installing contractor referencing each alarm input to every output function affected as a result of an alarm, trouble or supervisory condition on that input. In the case of outputs programmed using more complex logic functions involving "any," "or," "not," "count," "time," and "timer" statements; the complete output equation shall be referenced in the matrix.
3. The installing contractor prior to testing shall prepare a complete listing of all device labels for alphanumeric annunciator displays and logging printers.
4. The acceptance inspector shall use the system record drawings during the testing procedure to verify operation as programmed. In conducting the tests, the acceptance inspector shall request demonstration of any or all input and output functions. The items tested shall include but not be limited to the following:

a. System wiring shall be tested to demonstrate correct system response and correct subsequent system operation in the event of:
   1. Open, shorted and grounded intelligent analog signaling line circuit.
   2. Open, shorted and grounded network signaling line circuit.
   3. Open, shorted and grounded conventional initiating device circuits.
   4. Intelligent device removal.
   5. Primary power or battery disconnected.
   6. Incorrect device address.
   7. Printer trouble, off line or out of paper.
   8. Loss of data communications between system control panels.
   9. Loss of data communications between system annunciators.

b. System evacuation alarm indicating appliances shall be demonstrated as follows:
   1. All alarm notification appliances actuate as programmed.
   2. Audibility and visibility at required levels.

c. System indications shall be demonstrated as follows:
   1. Correct message display for each alarm input, at the control panel, each remote alphanumeric LCD display.
   2. Correct annunciator light for each alarm input, at each annunciator and color graphic terminal.
   3. Correct printer logging for all system activity.

d. System on-site and/or off-site reporting functions shall be demonstrated as follows:
   1. Correct alarm custom message display, address, device type, date and time transmitted for each alarm input.
   2. Correct trouble custom message display, address, device type, date and time transmitted for each alarm input.
   3. Trouble signals received for disconnect.

e. Secondary power capabilities shall be demonstrated as follows:
   1. System primary power shall be disconnected for a period of time as specified herein. At the end of that period, an alarm condition shall be created and the system shall perform as specified for a period as specified.
   2. System primary power shall be restored for forty-eight hours and system-charging current shall be normal trickle charge for a fully charged battery bank.
   3. System battery voltages and charging currents shall be checked at the fire alarm control panel using the test codes and displayed on the LCD display.

5. In the event of system failure to perform as specified and programmed at the discretion of the acceptance inspector, the test shall be terminated.
   a. The installing contractor shall retest the system, correcting all deficiencies and providing test documentation to the acceptance inspector.
   b. In the event that software changes are required during the testing, the system manufacturer to compare the edited program with the original shall furnish a utility program. This utility shall yield a printed list of the changes and all system functions, inputs and outputs affected by the changes. The items listed by this program shall be the minimum acceptable to be retested before calling for resumption of the testing. The printed list and the printer log of the retesting shall be submitted before scheduling of the testing.
   c. The acceptance inspector may elect to require the complete testing to be performed again if modifications to the system hardware or software warrant complete retesting.

D. Notify owner representative one week prior to all system testing days so they may witness tests.

E. Documentation:

1. System documentation shall be furnished to the owner and shall include but not be limited to the following:

a. Provide cut sheets for all equipment installed during construction. If multiple items are shown on one page indicate exactly which item was installed. Provide this information in hard copy and on CD with the record drawings.
b. System record drawings and wiring details including one set of reproducible hard copy, as well as, drawings on CD (compact disks) in a both CAD (or compatible program) and PDF.
c. System operation, installation and maintenance manuals.
d. Written documentation for all logic modules as programmed for system operation with a matrix showing interaction of all input signals with output commands.
e. Documentation of system voltage, current and resistance readings taken during the installation and testing.
f. System program “hard copy” showing system functions, controls and labeling of equipment and devices. Also provide a CD with system file.

F. Test Equipment: The contractor shall furnish to the owner all test equipment as required to program the field analog devices, specifically an intelligent device programmer-tester or a calibrated smoke generator with power source.

G. Warranty/Services: The contractor shall warrant the entire system against system hardware and electrical defects including programming software defects for a period described in the contract general conditions, but not less than one year. This period shall begin upon satisfactory completion and certification of final acceptance testing of the system. Contractor shall provide to owner a letter stating the start-date and end-date of warranty period. In addition, the contractor shall also provide an updated list of name(s) and phone number(s) for normal and off-hours contacts necessary to respond to warranty issues. Response to warranty notification shall require a reply within 24 hours of initial contact.

3.4 MAINTENANCE INSTRUCTIONS

A. Complete maintenance instructions for all devices including trouble-shooting procedures shall be provided to the owner. Owner’s personnel shall receive a minimum of six hours of hands on system training.

3.5 OPERATION AND MAINTENANCE MANUALS

A. Provide manuals in accordance with Section 16050. Manuals are to contain as-built drawings on disk utilizing Autocad, spare parts list, operating procedures, trouble shooting guide, operating system data file print out, operating system data file on disk, a one year service proposal on the system and a copy of the completed NFPA “Record of Completion.”

END OF SECTION

PART 1 - GENERAL

1.1 DESCRIPTION

A. Provide lighting control equipment complete and operable as specified herein and as shown on the Drawings.

1.2 QUALITY ASSURANCE

A. All lighting control equipment shall be UL and CUL listed and labeled and shall comply with the NEC.

B. Comply with FCC Regulations of Part 15, Subpart J, for Class A.

C. All equipment is this section to have a minimum 5 year warranty.

1.3 SUBMITTAL AND RECORD DOCUMENTATION

A. Submit product data for lighting control equipment and systems components, including dimensions and data on features and components. Include elevation views of front panels of control and indicating devices. Include data on ratings.

B. Submit wiring diagrams detailing specific systems tailored to this Project and differentiating between factory-installed and field-installed wiring.

C. Submit maintenance data for lighting control equipment and systems components to include in the operation and maintenance manual specified in Division 1.

PART 2 - PRODUCTS

2.1 TYPE 1 OCCUPANCY SENSORS (AUTOMATIC WALL SWITCH)

A. Sensor shall be capable of detecting presence in the control area by detecting infrared energy. Small movements shall be detected, such as when a person is writing while seated at a desk.

B. The sensor shall be a completely self-contained control system that replaces a standard toggle switch. Switching mechanism shall be a latching air gap relay, compatible with electronic ballasts, compact fluorescent, and inductive loads. Triac and other harmonic generating devices shall not be allowed. Sensor shall have ground wire and grounded strap for safety.

C. Sensor shall utilize advanced control logic based on RISC (Reduced Instruction-Set Circuit) microcontroller.

D. To avoid false ON activations and to provide immunity to RFI and EMI, a technology shall be used to respond only to those signals caused by human motion.

E. The sensor shall utilize continuously adjusting Zero Cross Relay control.

F. Sensors shall utilize ‘Smart Set’ technology to optimize time delay and sensitivity settings to fit occupant usage patterns. The use of Smart Set shall be selectable with a DIP switch.

G. Sensor shall have a time delay that is adjusted automatically (with the Smart Set setting) or shall have a fixed time delay of 5, 10, 15, 20 or 30 minutes, walk-through mode, or test mode, set by DIP switch. In walk-through mode, lights shall turn off 3 minutes after the area is initially occupied if no motion is detected after the first 30 seconds.

H. Sensor shall have the choice of light flash alert and/or audible alert of impending light shutoff.

I. Sensor shall have sensitivity adjustment that is set to either automatic or reduced sensitivity.

J. Sensor shall have a built-in light level feature selectable with DIP switch.

K. Sensor shall have automatic-ON or manual-ON operation.

L. Sensor shall operate at universal voltages.

M. Sensor shall be capable of switching 0-800 watts fluorescent/incandescent or 1/6HP @ 120VAC; 0 to 1200 watts fluorescent or 1/6 HP @ 230/277VAC.

N. The sensor shall utilize a temperature-compensated dual element sensor and a multi-element Fresnel lens.

O. Fresnel lens shall be made of hard, 1.0mm Poly IR 2 material for greater sensitivity and detection performance. Lens shall have grooves facing in to avoid dust and residue build up.

P. To assure detection at desktop level uniformly across the space, sensor shall have a two-level, 28-segment multi-element Fresnel lens system.

Q. Sensor shall cover up to 300 square feet for walking motion, with a field of view of 180 degrees.

R. The sensor shall not protrude more than 3/8” from the wall and should blend in aesthetically.

S. Adjustments and mounting hardware shall be concealed under a removable, tamper resistant cover.

T. Manufacturers: Watt Stopper PW-100 series.

2.2 TYPE 2 OCCUPANCY SENSORS (CEILING MOUNT, 360 DEG, DUAL TECHNOLOGY)

A. The Dual Technology sensor shall be capable of detecting presence in the control area by detecting Doppler shifts in transmitted ultrasound and passive infrared heat changes.

B. Sensor shall utilize Dual Sensing Verification Principle for coordination between ultrasonic and PIR technologies. Detection verification of both technologies must occur in order to activate lighting systems. Upon verification, detection by either shall hold lighting on.

C. Sensor shall have a retrigger feature in which detection by either technology shall retrigger the lighting system on within 5 seconds of being switched off.

D. Sensors shall be mounted to the ceiling with a flat, unobtrusive appearance and provide 360deg of coverage.

E. Ultrasonic sensing shall be volumetric in coverage with a frequency of 40 KHz. It shall utilize Advanced Signal Processing which automatically adjusts the detection threshold dynamically to compensate for constantly changing levels of activity and air flow throughout controlled space.

F. To avoid false ON activations and to provide immunity to RFI and EMI, a technology shall be used to respond only to those signals caused by human motion.

G. The PIR technology shall utilize a temperature compensated, dual element sensor and a multi-element Fresnel lens. The lens shall be Poly IR4 material to offer superior performance in the infrared wavelengths and filter short wavelength IR, such as those emitted by the sun and other visible light sources. The lens shall have grooves facing in to avoid dust and residue build up.

H. Sensors shall operate at 24 VDC/VAC and halfwave rectified and utilize a power pack.

I. Sensors shall utilize 'Smart Set' technology to optimize time delay and sensitivity settings to fit occupant usage patterns. The use of Smart Set shall be selectable with a DIP switch.

J. Sensors shall have a time delay that is adjusted automatically or shall have a fixed time delay of 5 to 30 minutes set by DIP switch.

K. Sensors shall feature a walk-through mode, where lights turn off 3 minutes after the area is initially occupied if no motion is detected after the first 30 seconds.

L. Sensors shall have a built-in light level sensor that works from 10 to 300 footcandles.

M. The sensors shall have a manual on function that is facilitated by installing a momentary switch.

N. Sensors shall have eight occupancy logic options that give the ability to customize control to meet application needs.

O. The sensor shall have an additional single-pole, double-throw isolated relay with normally open, normally closed and common outputs. The isolated relay is for use with HVAC control, data logging, and other control options.

P. Each sensing technology shall have an LED indicator that remains active at all times in order to verify detection within the area to be controlled. The LED can be disabled for applications that require less sensor visibility.

Q. Manufacturers: Watt Stopper DT-300 series.

2.3 TYPE 3 OCCUPANCY SENSORS (CEILING/WALL BRACKET MOUNT, DUAL TECHNOLOGY)

A. The Dual Technology sensor shall be capable of detecting presence in the control area by detecting Doppler shifts in transmitted ultrasound and passive infrared heat changes.

B. Sensor shall utilize Dual Sensing Verification Principle for coordination between ultrasonic and PIR technologies. Detection verification of both technologies must occur in order to activate lighting systems. Upon verification, detection by either shall hold lighting on.

C. Sensor shall have a retrigger feature in which detection by either technology shall retrigger the lighting system on within 5 seconds of being switched off.

D. Ultrasonic sensing shall be volumetric in coverage with a frequency of 40 KHz. It shall utilize a technology that automatically adjusts the detection threshold dynamically to compensate for constantly changing levels of activity and air flow throughout controlled space.

E. Sensor shall be capable of corner mounting to a wall or ceiling in order to eliminate detection through open doorways and outside of controlled area. Coverage of both technologies must be complete and overlapping throughout the controlled area.

F. To avoid false ON activations and to provide immunity to RFI and EMI, a technology shall be used to respond only to those signals caused by human motion.

G. Sensor shall operate at 24 VDC/VAC and halfwave rectified and utilize a power pack.

H. The PIR technology shall utilize a temperature compensated, dual element sensor and a multi-element Fresnel lens. The lens shall be Poly IR4 material to offer superior performance in the infrared wavelengths and filter short wavelength IR, such as those emitted by the sun and other visible light sources. The lens shall have grooves facing in to avoid dust and residue build up which affects IR reception.

I. The lens shall cover up to 2000 square feet for walking motion when mounted at 10 ft and 1000 sq ft of desktop motion.

J. DT-200 sensors shall have an additional single-pole, double throw isolated relay with normally open, normally closed and common outputs. The isolated relay is for use with HVAC control, data logging, and other control options.

K. Sensors shall utilize 'Smart Set' technology to optimize time delay and sensitivity settings to fit occupant usage patterns. The use of Smart Set shall be selectable with a DIP switch.

L. Sensors shall have a time delay that is adjusted automatically (with the Smart Set setting) or shall have a fixed time delay of 5 to 30 minutes.

M. Sensors shall feature a walk-through mode, where lights turn off 3 minutes after the area is initially occupied if no motion is detected after the first 30 seconds.

N. Sensor shall have an override-ON function for use in the event of a failure.

O. Sensor shall have a built-in light level sensor that works from 10 to 300 footcandles.

P. Each sensing technology shall have an LED indicator that remains active at all times in order to verify detection within the area to be controlled. The LED can be disabled.

Q. Manufacturers: Watt Stopper DT-200 series.

2.4 TYPE 4 OCCUPANCY SENSORS (CEILING MOUNT, ULTRASONIC)

A. The ultrasonic occupancy sensors shall be capable of detecting presence in the floor area to be controlled by detecting Doppler shifts in a transmitted ultrasound.

B. Ultrasonic sensing shall be volumetric in coverage with a frequency of 40KHz. It shall utilize a technology that automatically adjusts the detection threshold to compensate for changing levels of activity and airflow throughout the controlled space.

C. To avoid false ON activations and to provide immunity to RFI and EMI, a technology shall be used to respond only to those signals caused by human motion.

D. Sensors of varying frequencies shall not be allowed so as to prevent sensors from interfering with each other and to assure compatibility in the event more sensors are added.

E. The UT-300 sensor shall operate at 24 VDC/VAC and half-wave rectified and utilize a power pack.

F. UT-355 shall incorporate a switching power supply for reduced power consumption; shall operate at 120/230/277 VAC, and shall not require a power pack. The UT-355 shall be utilized in areas with inaccessible ceiling spaces.

G. Detection shall be maintained when a person moves only within or a maximum distance of 12 inches either in a horizontal or vertical manner at the approximate speed of 12 inches per second.

H. The UT-300 sensor shall have a manual 'on' function that is facilitated by installing a momentary switch.

I. Sensors shall be mounted to the ceiling with a flat, unobtrusive appearance and provide 360 deg of coverage.

J. Sensors shall utilize 'Smart Set' technology to optimize time delay and sensitivity settings to fit occupant usage patterns. The use of Smart Set shall be selectable with a DIP switch.

K. Sensor shall feature a walk-through mode, where lights turn off 3 minutes after the area is initially occupied if no motion is detected after 30 seconds.

L. UT-300 sensor shall have an additional single-pole, double throw isolated relay with normally open, normally closed and common outputs. The isolated relay is for use with HVAC control, data logging, and other control options.

M. Sensors shall have a time delay that is adjusted automatically (with the Smart Set setting) or shall have a fixed time delay of 5 to 30 minutes.

N. The sensor shall have an LED indicator that remains active at all times in order to verify detection within the area to be controlled. The LED can be disabled.

O. Approved Manufacturer: Watt Stopper UT-300, UT-355.

2.5 POWER AND AUXILIARY RELAY PACKS

A. Power pack shall be a self-contained transformer and relay module in a single small package.

B. Power and auxiliary relay packs shall have dry contacts capable of switching 20 amp ballast load, 13 amp incandescent, 1 hp @120 VAC; 20 amp ballast @ 277VAC; 15 amp ballast, 1 hp @ 220-240 VAC.

C. Power packs shall provide a 24 VDC, 150mA output/

D. Power packs shall be capable of parallel wiring without regard to AC phases on primary.

E. Auxiliary relay packs shall contain no transformer power supply and shall switch 120 VAC, 277 VAC or low voltage.

F. Power and auxiliary relay packs shall have low voltage Teflon coated leads, rated for 300 volts, suitable for use in plenum applications.

G. Power pack shall be UL 2043 rated, use UL94 V-O plenum rated plastic, and have low voltage Teflon leads for use in plenum applications.

H. Power packs shall utilize Zero Crossing Circuitry.

I. Manufacturers: Watt Stopper.

PART 3 - EXECUTION

3.1 INSTALLATION

A. It shall be the contractor's responsibility to locate and aim sensors in the correct location required for a complete and proper volumetric coverage within the range of coverage of controlled areas per the manufacturer's recommendations. The contractor shall provide the quantity of sensors necessary to properly and completely cover each room indicated to have occupancy sensing.

B. The contractor shall provide power packs as required to accomplish the occupancy sensing indicated.

C. Mount power packs to junction boxes in accessible locations and per the manufacturer's instructions.

D. Mount the sensors with adapters and/or swivels per the manufacturer's instructions.

E. It is the contractor's responsibility to arrange a pre-installation meeting with the manufacturer's factory authorized representative, at the Owner's facility, to verify placement of sensor and installation criteria.

F. The contractor shall provide, at the Owner's facility, the training to familiarize the Owner's personnel with the operation, use, adjustment, and problem-solving diagnosis of the lighting control equipment and systems.

3.2 TESTING

A. The lighting control equipment and systems shall be thoroughly tested to confirm proper operation.

END OF SECTION

PART 1 - GENERAL

1.1 INTRODUCTION

A. The provisions of the General Requirements, Supplementary Requirements, and Division 1 apply to the electrical work specified in this Section.

B. Contractor shall coordinate all work in this section with other sections and divisions of these specifications to provide a complete and operable system.

1.2 DESCRIPTION

A. Extent of lighting control system work is indicated by drawings and by the requirements of this section.

B. Type of lighting control equipment and wiring specified in this section include, but are not limited to, the following: Microprocessor based Low Voltage Lighting Control panels.

C. Requirements are indicated elsewhere in these specifications for work including, but not limited to, raceways and electrical boxes and fittings required for installation of control equipment and wiring.

1.3 QUALITY ASSURANCE

A. The control panels shall be tested and listed under the UL 924 Energy Management Equipment standards and CSA standards.

B. The control system shall comply with all applicable National Electrical Codes regarding electrical wiring standards.

C. All control equipment shall undergo strict inspection standards. The equipment shall be previously tested and burned-in at the factory prior to installation.

D. A factory-trained technician or factory-authorized personnel shall functionally test the control system and verify performance after installation.

F. Approved manufacturers: LC&D or approved equal.

1.4 SUBMITTALS

A. Submit manufacturer’s data on lighting control system and components.

B. Submit drawings of lighting control system and accessories including, but not limited to, low voltage relay panels, switches, photocells and other associated devices and equipment. Provide a One-Line drawing that must be project specific indicating all circuits and functions.

1.5 SYSTEM DESCRIPTION

A. Self contained lighting controller providing flexible time schedule control and override for lighting circuits. The standard relays are rated to directly switch 30A lighting loads. Low voltage override switches, motion sensors, and a photocell may be assigned to control the relays via programming.

PART 2 - PRODUCTS

2.1 MATERIALS AND COMPONENTS

A. Lighting Control Panels (LCP):

1. Microprocessor based with integral astronomic clock and calendar function. Provides individual schedules for each day of the week.
2. The LCP shall be capable of minimum 32 schedules. Each schedule shall consist of one set of On and Off times per day for each day of the week and for each of two holiday lists. The schedules shall apply to any individual relay or group of relays.
3. NEMA 1 rated enclosure with a hinged locking door.
4. A steel barrier shall separate the high voltage and low voltage compartments of the panel and separate 120v and 277v.
5. LCP input power shall be capable of accepting 120v or 277v.
6. Program entry shall be via an integral keypad and illuminated 4-line, 80 character LCD display.The leypad shall provide individual quick-access keys that are associated with each input, each relay, and each day of the week. Programming steps shall be prompted on the display in clear alphanumeric format. A ‘help mode’ function shall be incorporated into the programming system.
7. The program shall be run from non-volatile memory so that all system programming and real time clock functions are maintained for a minimum of 10 years with loss of power.
8. Manual overrides shall be provided for individual relays, zones or entire panel.
9. Provide with eight low voltage input terminals for connection of switches, occupancy sensors or other override devices.

C. Relays

1. UL Listed 30 Amp, latching or electrically held, 277VAC Ballast and HID and 20 Amp Tungsten at 120 VAC.
2. Relays shall be replaceable. Relay terminal blocks shall be capable of accepting two (2) #10AWG wires on both the line and the load side.
3. Relays to be rated for 250,000 operations minimum at a full 30a lighting load, default to closed at normal power loss, Normally Closed (NC).
4. Optional relay types available shall include: Normally Open (NO) relay rated for 250,000 operations, a 600v 2-pole NO and NC and a Single Pole, Double Throw (SPDT) relay.

D. Photocell: Photocell shall be analog or digital and shall provide multiple trip points from one roof mounted unit. All trip points shall be adjustable through the program and not require that adjustments be made at the remote photocell location. Photocell to be certified to comply with the current energy code covering this project at time of submittal of plans for building permit.

PART 3 - EXECUTION

3.1 EQUIPMENT INSTALLATION AND DOCUMENTATION

A. Installation: The control panels shall be installed, connected and fully wired as shown on the plans.

B. Documentation: The contractor shall provide record drawings to the owner for correct programming and proper maintenance of the control panel. The record drawings shall indicate the load controlled by each relay and the relay panel number.

C. Operation and Service Manuals: Upon completion of Contract submit Operating and Maintenance Manuals for inclusion in Owner's Maintenance Brochure as specified in Division 1.

3.2 PRODUCT SUPPORT AND SERVICE

A. Factory Support: Factory telephone support shall be available at no cost to the owner. Factory assistance shall consist of solving programming or application questions concerning the control equipment.

3.3 SYSTEM ACCEPTANCE

A. The contractor is responsible for complete installation of the system according to factory standards and requirements. The following items shall constitute factory standards and requirements:

1. All system equipment shall operate in accordance with specifications.
2. An operational user program shall exist in the control system. The program shall execute and perform all functions required to effectively operate the site according to the requirements.
3. Demonstration of program integrity during normal operation and pursuant to a power outage.
4. Contractor shall provide minimum two hours of training on the operation and use of the control system. Additional support services shall be negotiated between the contractor and the building owner or manager.

3.4 WARRANTY

A. Manufacturer shall supply a 3-year warranty on all hardware and software. A limited 10-year warranty shall be provided on the individual relays.

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

A. Hillside Elementary School located in Eagle Point, Oregon.

B. This is project is for new construction.

1.2 RELATED DOCUMENTS

A. Plans

B. Division 1

C. Division 16

D. Division 17

1.3 SUBMITTALS

A. Requirements to submit on project

1. Meet requirements in Section 17010.
2. Additional requirements may be set by Architect.

PART 2 - OVERVIEW

2.1 SYSTEMS

A. Phone system work will consist of backbone cabling from the utility demarcation point to the MDF and tie cable from the MDF to the IDF. The horizontal cabling will extend from both the MDF and IDF to outlets in offices and classrooms.

B. Data system cabling will consist of a fiber optic tie cable from the MDF to the IDF as well as horizontal cabling from both the MDF and IDF to outlet locations.

C. Paging and Intercom system will provide a zone per classroom with two-way communication provided by two-way speakers. Each classroom will be provided a call button to initiate communication with the office. There will be a general space zone for interior corridors and gathering spaces, a zone for the exterior of the school, and a zone for the gymnasium.

D. Master clock system will be provided as part of the paging/intercom system to announce class change tones. The clocks will be owner furnished owner installed.

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes basic design requirements and specifications for the Low Voltage Systems.

B. This Section contains requirements that pertain to all 17000 series sections, and includes the design basis, as well as requirements for submittals, quality assurance, product handling, record documents, project conditions, installation, testing, demonstrations and training.

C. Within the appropriate section will be more specific information necessary for the construction of the systems required for this project.

D. Provide all items, articles, materials, equipment, operations and/or methods listed, mentioned, shown and/or scheduled on the Drawings and/or in these Specifications, including all labor, supervision, services, permits, fees, and incidentals necessary and required to provide a complete and operable facility with complete systems as shown, specified, and required by applicable codes.

E. The work shall include but not be limited to: Telephone service conduit, terminal boards, terminal cabinets, outlets, raceway systems, and grounding per utility requirements.

1.2 RELATED DOCUMENTS

A. Drawings

1. Symbols used on the drawings are defined in the symbols schedule of the drawings. Some of the symbols scheduled may not be required for the project.
2. Because of the scale of the drawings, symbols are shown on drawings as close as possible to the mounting location. Verify exact locations with the onsite Representative.
3. Drawings are diagrammatic, intended to convey the extent, general arrangement and locations of the work. Because of the scale of the drawings, certain basic items such as conduit fittings, access panels, cabinet sizes, sleeves, pull boxes, back boxes and junction boxes may not be shown. Include all items where required by code, other Sections, and for proper installation of the work.

B. Provisions of the General Requirements, Supplementary Requirements, and Division 1 apply to the work specified in this section.

C. All Division 17 Specifications

1.3 REFERENCES AND REGULATORY REQUIREMENTS

A. BISCI TDMM, Latest Edition (Telecommunications Distribution Methods Manual)

B. National Fire Protection Association (NFPA)

C. National Electric Code (NEC)

D. Americans with Disabilities Act (ADA)

E. Institute of Electrical and Electronics Engineers (IEEE)

F. Underwriters Laboratories (UL)

G. International Building Code (IBC)

H. International Fire Code (IFC)

I. Occupational Safety and Health Administration (OSHA)

J. Authorities Having Jurisdiction (AHJ)

K. TIA/EIA-568-B (and all addendums) Commercial Building Standard for Telecommunications Pathways and Spaces

L. TIA/EIA-569-A (and all addendums) Commercial Building Telecommunications Cabling Standard

M. TIA/EIA-606 Administration Standard for Commercial Telecommunications Infrastructure

N. TIA/EIA-607 Commercial Building Grounding and Bonding Requirements for Telecommunications

O. TIA/EIA-758 (and all addendums) Customer Owned Outside Plant Telecommunications Cabling

P. TIA/EIA-TSB series of Guidelines

1.4 REQUIREMENTS

A. Manufacturer

1. Must provide an “End-to-End Solution” on the system being installed i.e., products of a single manufacturer for similar type equipment, i.e., cable, jacks, patch panel.
2. Have verified testing and documentation showing the parameters and abilities of the system as installed.
3. The system and its components must be manufactured by a company engaged in the manufacture of the specific equipment for a minimum of 3 years.
4. Must be listed in the approved manufacture listing within the appropriate section.

B. Contractor

1. Documented successful work experience of at least 10 facilities of equivalent size and technical requirements utilizing the equipment proposed to be used.
2. Have a designated Project Manager for the site with documented experiences from at least 5 other projects of similar size and technical difficulty.
3. Have enough trained installers to meet the schedule of the project, without causing delay.
4. Must be Licensed and Bonded.

C. System Installers

1. Shall have no less than 3 years of documented work experience on projects of equivalent size and technical difficulty. If you are using a Subcontractor their installers must meet the requirements, this is a requirement of the installer not the bidder.
2. “Experience” is defined as the completion of an operational system, with the system being successfully operated by the customer for its intended purpose for at least one year.
3. Must have current certification, from the Manufacturer, on the system to be installed so the customer may benefit from the best warranty available from the manufacturer.

D. Any errors made in the plans or specifications are to be brought to the attention of the architect to be resolved before construction begins.

E. All work done is to meet the Codes and requirements listed above. The most stringent having precedence over the others.

F. The equipment and material being submitted for this project shall be an “End-to-End Solution” for compatibility and warranty by manufacturer.

1.5 SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES

A. Submit in accordance with Division 1 full technical and descriptive shop drawing data on proposed materials and equipment as detailed in each section.

1. Include dimensions, wiring and block diagrams, conduit sizes, performance data, ratings, control sequences, and all other descriptive data necessary to describe the item proposed and its operating characteristics.
2. Shop drawings need to be submitted as hard copy and electronic format. Electronic format shall be ACAD R.14 or later, using the same scale as used on the bid set.
3. Symbols used on the Shop Drawings shall match the symbols used on the Bid Set.
4. Coordinate with other applicable trades in submittal of shop drawings.
5. Shop drawings shall detail space conditions to accommodate other concerned trades, subject to final review by the Architect.

B. The Contractor shall verify that all equipment submitted can be delivered and installed within the time constraints of the construction period.

C. Include the manufacturer, type, style, catalog number, complete specification, certified dimensions, and description of physical appearance for each item and option submitted. Reproduction of catalog data sheets shall be clean and legible to show all details, including gauge of metal used.

D. Include only information on exact equipment to be installed, not general catalogs of the manufacturer. Where sheets show proposed equipment as well as other equipment, identify proposed equipment with rubber stamp arrow or similar concise method.

1. Submit complete technical data necessary to evaluate the material and equipment. Include a complete technical specification for the submitted equipment, noting differences and adherence to this Section.
2. Submittals need to be clear and concise requiring no interpretation by the contractor to be clearly understood. Products to be used, within a system, shall be grouped within the submittals so the system can be clearly understood.
3. Data sheets are to be submitted in a 3-Ring binder, separated by systems if a particular piece is to be used for multiple systems show it in each section.

E. Submit with each copy a transmittal letter verifying that all included equipment submittals have been carefully considered for quality, dimensions, function, and have been coordinated with the Drawings and Specifications. Guarantee that proposed materials will meet or exceed the quality and function of those specified.

F. Include wire run and connection diagrams for all signal and/or low voltage systems, including floor plans.

G. Submittal Review: The submittal review process is a means to determine quality control. The action noted to be taken (or where conflicts with the contract documents are not noted) shall not

be interpreted by the Contractor as automatic "change orders." Approval of the data for substitution and shop drawings shall not eliminate the contractor's responsibility for compliance with Drawings or Specifications, nor shall it eliminate the responsibility for freedom from errors of any sort in the data discovered prior to or after the review process. Deviations, discrepancies, and conflicts between the submittals and the Contract Documents shall be called to the Architect's attention in writing at the time of transmittal of the data.

H. Unless otherwise directed by Division 1, submittal data shall be in a 3-ring plastic binder with a clear plastic sleeve and a project identification sheet inserted. Arrange submittals numerically with specification sections identified on divider tabs. All required sections shall be submitted at one time.

I. Samples

1. Provide Workstation outlet sample including faceplate, jacks, and proposed labeling.
2. Confirm acceptance of colors and design with architect prior to ordering.

J. Submit a list of at least 5 facilities of equal size and technical requirements utilizing the equipment submitted.

1. For each facility, list:
   a. Name and location of facility.
   b. Date of Occupancy by customer.
   c. Representative to contact and telephone number.
   d. Construction Manager or General Contractor.
   e. Provide information on the installed locations with operational equipment.

K. Certifications

1. Copies of certifications held by employees for the system to be installed.
2. Certificates shall be from the manufacturer or facility that provided the training listing the employee who has successfully passed the program.

1.6 WARRANTY

A. All work is to be performed in a manner so the customer may benefit from the most complete warranty available by the manufacturer.

B. The installing company is to submit all paperwork, on behalf of the customer in the customer's name, to the appropriate manufacturer so the installed system is covered by warranty.

C. A one-year warranty is to be provided by the installing contactor for hardware, cable and terminations. All work/cost required to replace a defective item is to be covered by the warranty.

1.7 OPERATING AND MAINTENANCE DATA

A. Operation and Maintenance Data for the electronic systems shall include layout drawings of each panel with each item of equipment identified and cross referenced with equipment data sheet. Operation and Maintenance Data shall include complete terminal block schedule for each panel with the following data for each point:

1. Type of point, i.e., input, output, etc.
2. Schedule relating points, terminal block numbers, and signal source or destination.
3. Input and output schedule.
4. Location and type of input source device.
5. Location and type of output device controlled.

6. Project-specific, illustrated user's manual.
7. Provide detailed electrical schematics for all electrical/electronic components.

B. All Operation and Maintenance Data shall include "record drawing" system interconnection diagrams with major components identified and number and type of interconnecting conductors. Submit two copies of each record drawing.

1. Floor plan drawings shall be provided showing location of equipment and routing of conduit and cable.

C. Maintenance and operating instructions on all systems.

D. Control wiring diagrams for all locking systems with each system identified.

E. Certification from system manufacturers that systems are installed in accordance with manufacturer's recommendations and are functioning correctly at the time of final inspection.

1.8 QUALITY ASSURANCE

A. Design Requirements

1. Provide and install all related devices, equipment and appurtenances necessary to complete the work as a complete and fully operational system.
2. All materials, hardware, and electronics are to be delivered to the site in the original packaging. Used or remanufactured material will not be allowed.
3. All cabling shall be routed through dedicated concealed raceways unless otherwise indicated. All raceways shall be a minimum 1 inch unless otherwise noted. Size raceways and install conductors in accordance with the NEC, NFPA, and TIA/EIA.
   a. EMT conduit with compression fittings may be utilized in all inaccessible areas unless otherwise required by code.
   b. Rigid metal conduit with Liquid-tight Fittings shall be used in exposed exterior applications.
   c. PVC conduits shall be used in underground applications; stub-ups shall be rigid metal conduit.
   d. Rigid metal conduit shall be used in all interior accessible areas where concealed conduit requirements cannot be met. Submit drawings, diagrams and information to Customer's Representative for review prior to work.
   e. All conduits shall terminate, whether in Pull-box or not, with the appropriate size End-fitting with a bushing to protect cable from abrasion.
4. Mounting heights and accessibility to equipment requiring access by individuals with disabilities shall comply with ADA requirements.
5. Outdoor enclosures shall be NEMA 4 rated

B. Equipment specifications may not deal individually with every part, control, or device, which may be required to produce the equipment performance specified or as required to meet the equipment warranties. Include such items, as required, for a complete operational system, whether or not specifically indicated.

C. All equipment contained in Division 17 Sections shall be year 2000 compatible.

1. Computer Rooms Access Control System
2. Closed Circuit Video Equipment
3. Intercom/Paging/Listen-in System
4. Emergency Light Systems
5. Nurse Call
6. Security Systems

D. If installation of equipment, raceways, cable trays and/or conduit is performed prior to coordination with other trades, which interferes with work of other trades, make necessary changes to correct the condition at no additional cost to the customer.

E. If R&I (Removal and Installation) of existing equipment is needed. The awarded contractor must test systems PRIOR to any removal. If any component is not working it needs to be brought to the attention of the onsite representative. If this is not accomplished, any component not working after install that was part of R&I, will be replaced with a new unit at no additional cost to the customer.

F. All work and materials shall conform to all applicable local and state codes and all federal, state and other applicable laws and regulations. All clarifications and modifications which have been cleared with appropriate authorities are listed under the applicable sections. All electrical products shall bear the UL label.

G. Whenever the requirements of the Specifications or Drawings exceed those of the applicable code or standard, the requirements of the Specifications and Drawings shall govern.

H. The Drawings and Specifications are complementary. What is called for by one shall be as though called for by both.

1.9 PRODUCT DELIVERY, STORAGE AND HANDLING

A. All materials and equipment are to be delivered in the original manufacturer packaging and shall be of the latest design available from manufacturer.

B. Provide and apply protective covering immediately upon receiving the products and maintain throughout the construction process.

C. Protect materials stored on the job site, during construction, after installation, and until time of substantial completion.

D. Keep products clean and dry, elevate equipment above ground and floor.

E. Any material damaged, before time of substantial completion, is to be replaced at no cost to the customer.

F. Equipment shall not be delivered to site more than 2 weeks prior to install by cabling contractor.

G. Location to store materials, on site, will be designated by General Contractor or Customer Representative depending on the project.

1.10 RECORD DOCUMENTS

A. Electrical General Requirements provide complete schematic drawings depicting location of interface, number of conductors, types of connectors, and type of enclosure.

1.11 PROJECT CONDITIONS

A. Active Services: Protect existing active services, water, gas, sewer, electrical, when encountered, against damage. If active services are encountered which require relocation, notify the Architect promptly in writing.

B. Additional information is provided in Section 17050.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable manufacturers

1. Manufacturer must provide an “End-to-End Solution” for the system to be installed.
2. Product line must be conformance with the specifications.
3. Where manufacturers have been named, use one of those named.
4. Manufacturers may be designated in the appropriate Section for the system involved.

2.2 MATERIALS

A. Materials shall be of the proper designation and design for the area in which they are to be installed so as to be in compliance with all Standards and Codes i.e. plenum or OSP rated.

B. All anchors used for the support of any equipment are to be of the appropriate design and load rating for that area as set by manufacturer recommendations.

PART 3 - EXECUTION

3.1 LAYOUT AND COORDINATION

A. The Contractor shall inspect the job site prior to bidding and become familiar with existing conditions which will affect his work. The Drawings are diagrammatic indicating approximate location of outlets, lighting fixtures, electrical equipment, etc. Consult the Architectural, Structural and Mechanical Drawings to avoid conflicts with equipment, structural members, etc. When required, make all deviations from Drawings to make the work conform to the building as constructed, and to related work of others. Minor relocations ordered prior to installation may be made without added cost to the Owner.

B. Obvious omissions from Drawings or Specifications or differences between Drawings and Specifications shall be called to the Architect's attention at least ten (10) days prior to the bid date for clarification. Failure to do so will be construed as the willingness of this Contractor to supply all necessary materials and labor required for the proper completion of this work in a manner approved by the Architect.

C. Call to the attention of the Architect any error, conflict or discrepancy in Drawings and/or Specifications. Do not proceed with any questionable items of work until clarification of same has been made.

D. Supplementary details and plans may be supplied as required and they will become a part of the Contract Documents.

E. Work under this Division shall be conducted in a manner to cooperate with all other trades for proper installation of all items of equipment.

F. Coordination of work with other crafts employed on the project is mandatory. Arrange work to reduce interruption of existing services to minimum. When interruptions are unavoidable, consult Architect and utilities involved and agree in writing, with copy to the Architect, upon a mutually satisfactory time and duration.

G. Verify the physical dimensions of each item of electrical equipment to fit the available space and promptly notify the Architect prior to roughing-in if conflicts appear. Coordination of equipment

to fit the available space and the access routes through the construction shall be the Contractor's liability.

H. Locations of items shown on the Drawings as existing are partially based on record and other drawings which may contain errors. The Contractor shall verify the correctness of the information shown prior to rough-in or demolition and notify the Architect of any discrepancies.

I. Coordinate all work and trim with carpet installers. Provide carpet plates on all carpet surfaces, complete as required.

J. Install equipment such that code-required working clearances are maintained, and allow clearances for future maintenance.

K. Coordinate installation of electrical conduit, boxes, fittings, anchors, and miscellaneous items to be concealed in precast concrete assemblies.

3.2 PROTECTION OF EQUIPMENT

A. Protect materials stored on the job site. Protect equipment until time of Substantial Completion.

B. Provide and apply protective material immediately upon receiving the products and maintain throughout the construction process.

C. Failure to protect materials constitutes sufficient cause for rejection of the apparatus or material.

D. Protect factory finish from damage during construction operations and until final acceptance. Restore finishes that become stained, scratched, or damaged.

E. Protect existing equipment from any damage during the construction process.

3.3 INSTALLATION

A. Install all devices and equipment in accordance with standards set by industry practice and manufacturer’s requirements.

B. Use only highly skilled and experienced workers certified by the manufacturer of the system involved.

C. When change in location or size is required, obtain approval of Architect before making change.

D. Do not make any changes without written approval of Architect.

E. Provide to Division 16 installer all non-standard electrical boxes.

F. Fill percentage: Conduit fill shall not exceed 40 percent.

G. Install conductors, control and communications cables, coaxial cables, etc., for the work of this division according to code, standard, or manufacturer recommendations which ever is the most stringent.

H. Provide installation, including connections, cable pulling, testing and interfacing of systems.

I. Execute all work described in this specification and shown on drawings and all work dependent upon, and necessary to, complete finish of the work so described or shown, in a workmanlike

manner using materials best adapted to purposes where such work or material is not specifically mentioned.

J. Fire stopping is to be completed on all penetration occupied by material installed by communications contractor. Whether the penetration was made by the contractor or for the contractor, if your company is utilizing the sleeve or conduit you are responsible for the Fire-Stopping to meet the TIA/EIA Standards.

3.4 TESTING AND DEMONSTRATION

A. Tests

1. Notify customer's representative in writing, in advance of testing to prevent delays in construction schedules.
2. Test all systems and place in proper and specified working order prior to demonstration of the systems.
3. Test system grounds to demonstrate that the ground resistance does not exceed the requirements of the Transient Voltage Surge Suppression (TVSS) or the National Electric Code (NEC).
4. Perform tests, as required, by authorities having jurisdiction over the site.
5. Testing shall be in the presence of the customer's designated representatives, Contractor, and representatives of the authorities having jurisdiction.

B. Verification of Performance

1. Prior to acceptance of the work, the System Integrator/Installer shall demonstrate to the customer, designated representatives, Contractor, and representatives of the authorities having jurisdiction, all subsystems, features and functions of the system, and shall instruct the customer in the proper operation and event sequences of the system.
2. Demonstrate each system and subsystem. The demonstration is to consist of not less than the following:
   a. Designate actual location of each component of a system or subsystem and demonstrate its function and its relationship to other components within the system.
   b. Demonstrate the systems and subsystems operations by actual "START-STOP/ON- OFF/OPEN-CLOSE" cycling showing how to work controls, how to reset devices, how to replace fuses and emergency operating/operations procedures.
   c. Demonstrate communication, signaling and door control equipment/devices by actual operation of such devices.

C. Systems for training and demonstration may include but are not limited to.

1. Graphic Control Panel Operations.
2. Vehicular Sally Port And Door Control System.
3. Computer Rooms Access Control System.
4. CCTV System.
5. Intercom/Paging System.
6. Emergency Light System.
7. Entry System
8. Security
9. Telephone Systems.

D. Demonstration

1. System Integrator/Installer shall furnish the necessary trained personnel to perform the demonstration and instructions or arrange to have the manufacturer's representatives present to assist with the demonstrations. Training time shall include, as a minimum, the total time determined by the sum of the times specified in each Section, for performing the prescribed demonstrations/training.
2. System Integrator/Installer shall arrange with the customer's designated representative the date and times for performing the demonstrations. The customer will select date and time for demonstration.
3. Comply with requirements for Systems Demonstrations in each Section.

3.5 INSPECTIONS

A. At the completion of the project and prior to final acceptance of the work, provide evidence of final inspections and approvals to the customer, as required by the authorities having jurisdiction.

3.6 CUSTOMER TRAINING

A. Include

1. Train Operations and Maintenance Personnel in use and maintenance of systems provided under this section.
2. Train maintenance staff in troubleshooting and maintenance of each system.
3. Provide copies of technical manuals, including function and operational circuit and operational circuit characteristics and schematic diagrams, for each system and system components.

B. Training sessions

1. Shall be conducted by instructors certified in writing by manufacturer of specific system
2. Conduct sessions for not less than four-hour periods during normal working hours, i.e., Monday through Friday, 8:00 AM to 5:00 PM.
3. Training session schedules shall conform to requirements of customer.
4. Submit schedules to the customer for approval not less than two weeks prior to training session.
5. Do not schedule training sessions for different systems concurrently.
6. Give 20 hours of instruction on each system to the customer to assure that personnel are fully trained.

C. Instruct operating staff in proper operation, including hands-on training.

END OF SECTION

PART 1 – PRIOR TO PROJECT

1.1 SUBMITTALS

A. Plans and One-Line Drawing

B. Product Data and Samples

C. References and Certifications

D. Name and Phone Number or Project Manager for project.

E. Submit three complete sets of Submittals as described in Section 17010.

1.2 WALK-THROUGH

A. Pre-bid walk-through may be mandatory for bidding. Always verify with whomever you are placing the bid.

B. Your name must appear on the “Sign In Form” at the walk-through in order to bid.

C. If you are using a Subcontractor and they do not attend the walk-though you will be responsible for them receiving the information. Only names on the list will receive updates on the project.

1.3 BIDDING

A. All conditions in the Division 17 specifications must be meet in order to bid on this project, in addition to conditions set in Division 1.

B. Other Bidding requirements may be set by Architect.

PART 2 – DURING CONSTRUCTION

2.1 PROJECT MANAGEMENT

A. A Project Manager is to be present at ALL construction meetings to answer questions of progress, discuss scheduling and resolve any issues that may arise.

B. When construction has started but the Contractor is not onsite actively working. The Project Manager, when requested, will be onsite within 24 hours from time of request.

C. The Project Manager is to be onsite when any work is actively being done.

D. The Project Manager will be the single point of contact, for the Architect, General Contractor, and Owner Representative, so the flow of information will be as efficient as possible.

2.2 MEETINGS

A. Contractor is to have job-site meetings with technicians informing them of scheduling and any safety issues that may have come up in the construction meetings. Items to be covered are

over-head dangers, open trenches, area's that may be off limits due to safety issues or work in progress, and locations of all items on job-site.

B. Project Manager is to conduct all meetings with technicians.

C. If the Project Manager needs to call a meeting with Architect, General Contractor, or Owner Representative allow 48 hours from time of notice before meeting is to begin.

PART 3 – PROJECT COMPLETION

3.1 JOB SITE

A. All materials, storage container, job shacks, and dumpsters must be removed from job-site by final or when customer begins to occupy the space which ever may come first.

B. All labeling must be completed to customer's satisfaction by the final.

C. All repairs must be completed by the final.

3.2 DOCUMENTATION

A. As-Builts consisting of detailed plans showing exactly where items have been installed as well as risers showing wiring connections to be delivered within 2 weeks of final.

B. Test results are to be delivered within 2 weeks from test date.

C. All manuals and warranty information are to be delivered with the As-Builts.

END OF SECTION

PROJECT MANAGEMENT AND QUALITY ASSURANCE

PART 1 - GENERAL

1.1 WORK INCLUDED

1.2 SYSTEM OPERATION

1.3 SUBMITTALS

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

2.2 CONTROL PANEL

2.3 SOFTWARE

2.4 ANNUNCIATORS

2.5 ALARM INITIATING DEVICES

2.6 VOICE EVACUATION EQUIPMENT

PART 3 - EXECUTION

3.1 OPERATION

3.2 INSTALLATION

END OF SECTION

PART 1 - GENERAL

1.1 SUBMITTALS

A. Shop Drawings

1. Include dimensions, wiring and block diagrams, conduit sizes, performance data, ratings, control sequences, and all other descriptive data necessary to describe the item proposed and its operating characteristics.
2. Shop drawings need to be submitted as hard copy and electronic format. Electronic format shall be ACAD R.14 or later, using the same scale as used on the bid set.
3. Symbols used on the Shop Drawings shall match the symbols used on the Bid Set.
4. Coordinate with other applicable trades in submittal of shop drawings.
5. Shop drawings shall detail space conditions to accommodate other concerned trades, subject to final review by the Architect.

B. Data Sheets

1. Submit complete technical data necessary to evaluate the material and equipment. Include a complete technical specification for the submitted equipment, noting differences and adherence to this Section.
2. Submittals need to be clear and concise requiring no interpretation by the contractor to be clearly understood. Products to be used, within a system, shall be grouped within the submittals so the system can be clearly understood.
3. Data sheets are to be submitted in a 3-Ring binder, separated by systems if a particular piece is to be used for multiple systems show it in each section.
4. Requirements listed in Division one could be more stringent then requested here always verify exact requirements with whomever you are placing the bid.

C. Operation and Maintenance Data for the electronic systems shall include layout drawings of each panel with each item of equipment identified and cross referenced with equipment data sheet. Operation and Maintenance Data shall include complete terminal block schedule for each panel with the following data for each point:

1. Type of point, i.e., input, output, etc.
2. Schedule relating points, terminal block numbers, and signal source or destination.
3. Input and output schedule.
4. Location and type of input source device.
5. Location and type of output device controlled.
6. Project-specific, illustrated user’s manual.
7. Provide detailed electrical schematics for all electrical/electronic components.

D. All Operation and Maintenance Data shall include “record drawing” system interconnection diagrams with major components identified and number and type of interconnecting conductors. Submit two copies of each record drawing.

1. Floor plan drawings shall be provided showing location of equipment and routing of conduit and cable.
2. Provide an electronic copy of plans (pdf) and test results in a format that does not require proprietary software to read.

END OF SECTION

PART 1 - GENERAL

1.1 DESCRIPTION

A. This specification will cover the various grades of cables required for this project and will be further defined in other sections.

B. All cabling installed will be per manufacturer recommendation and industry standards. All components of support and routing required for a complete and functional system whether specified or not are to be part of the bid.

1.2 QUALITY ASSURANCE

A. Equipment and devices are to be listed by Underwriters Laboratories, Inc.

B. See Section 17010 for additional requirements.

1.3 SUBMITTALS

A. Submit product data describing all equipment.

B. See Section 17010 for additional requirements.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Manufacturer must comply with End-to-End solution requirement, verify hardware manufacturer.

2.2 DESCRIPTION

A. Horizontal cabling as part of the End-to-End will be dictated by termination equipment to maintain the warranty available from the manufacturer.

B. Tie cable will be of indoor, indoor/outdoor, or underground rating depending the location to be installed.

C. Fiber optic cabling will be indoor, indoor/outdoor, or underground rating depending the location to be installed.

D. Speaker wire will be audio grade cabling.

E. Multi conductor as required per system installed for the use of.

PART 3 - EXECUTION

3.1 INSTALLATION

A. All cable is to be installed in the most efficient route possible. No cable route will have more the 40% fill as recommended by the TIA/EIA Standards.

B. All equipment and wiring shall be guaranteed against defects in materials and workmanship for a one year period from the start up and beneficial use of the system.

C. Cabling is to be installed following manufacture requirements for bend radius and pulling tension. Cable is to be supported every 5 feet.

D. Cabling that is to utilize a conduit path shall not be installed until the path is complete with End Connectors and Bushings in place.

E. Cabling shall be separated by industry standards for life safety and to prevent EMI.

F. It is the responsibility of the contractor that is awarded the project to confirm the schedule for installation with the General Contractor.

G. Any inspections that are needed are to be scheduled by the contractor awarded the job.

H. Any cable that has been installed and fails a visual inspection or industry standard tests is to be replaced at no cost to the owner, and in a manner that will not cause any delay to the construction schedule.

I. Exterior grade copper gel filled cable will either splice to an interior grade of the appropriate rating within 50’ in an approved splice case or terminate to a Protection Entrance Terminal.

J. Exterior grade fiber optic gel filled cable will splice to an interior grade of the appropriate rating within 50’ in an approved splice case.

END OF SECTION

PART 1 - GENERAL

1.1 DESCRIPTION

A. The IT Room will house the electronics for the network equipment, phone equipment, security and observation systems. Coordinate cable routing and power requirements with other trades utilizing the space.

B. All equipment, sleeves, bushing, fire-stop and accessories needed to make this a safe and useable area whether specified or not are to be a part of the contractor's submittals and implemented in the space during construction.

1.2 QUALITY ASSURANCE

A. All equipment shall be UL listed.

B. All equipment shall be installed in a neat and professional manner.

C. Communication grounding and bonding shall be in accordance with applicable codes and regulations. It is recommended that the requirements of IEC, NEC, and ANSI/EIA/TIA-607 shall be observed throughout the entire space.

D. Refer to Specification 17010 for additional requirements.

1.3 SUBMITTALS AND PRODUCT DATA

A. Include shop drawings depicting wiring and connection diagrams in addition to the requirements in other parts of this Specification.

B. The drawings submitted need to show the amount of space, mounting design, and power requirements needed for the systems.

PART 2 - PRODUCT

2.1 ACCEPTABLE MANUFACTURERS

A. Cable terminations shall comply with hardware specified in Horizontal Cabling specification.

B. Rack and support hardware; Chatsworth Products (CPI), Damac, Hubbel Premise, Panduit, Ortronic or approved equal.

2.2 MATERIAL

A. Plywood

1. ¾"x 4'x8'
2. AC grade
3. Fire-rated or painted all sides fire rated or latex paint depending on utility requirements and local codes.

B. Equipment Rack

1. Floor Standing
2. Compatible with EIA 1 ¼”-1/2” hole pattern, both sides
3. UL Listed
4. Finish as listed on plans
5. Size as listed on plan

C. Cabinet

1. Wall mounted
2. Compatible with EIA 1 ¼”-1/2” hole pattern, both sides
3. Side vented
4. Double hinge lockable
5. Plexi-glass door
6. UL Listed
7. Finish as listed on plans
8. Size as listed on plan

D. Ladder Rack/Cable Tray

1. UL listed
2. Include all connecting hardware recommended by manufacturer. Including but not limited to rack-to-runway mounting plate, wall angle support bracket, junction spice kit, and grounding/bonding.

E. Patch Panels for Structured wiring

1. Mounting pattern per industry standard
2. 48 port Universal Pin-out
3. 19” rack mountable

F. Patch Panels for Voice Tie Cable

1. Mounting pattern per industry standard
2. 48 port Universal Pin-out
3. 19” rack mountable

G. Fiber Optic Shelf

1. 19” rack mountable
2. Include cover and tough
3. Capacity as dictate by strand count or indicated on plans.

H. Horizontal Cable Managers

1. Single or Double sided as shown on plans
2. Number of rack spaces as shown on plans

I. Vertical Cable Managers

1. Finish to match Racks
2. Single or Double sided as shown on plans
3. Pass through ports
4. Bolts to standard industry rack bolt pattern
5. Required to have some means of securing cable within the manager whether covers or latch.

J. Solid ground wire #6 AWG.

K. D-Rings

L. Fire-Stop
1. Appropriate rating for wall penetrated.
2. Re-enterable

M. Hilti HDI drop in anchors

N. Velcro cable ties

PART 3 - EXECUTION

3.1 INSTALLATION

A. Plywood

1. Plywood is to be mounted to the wall finished side into the room.
2. Anchors are to be flush or recessed.
3. Sand smooth and paint all sides white with Latex paint.
4. Plywood will be mounted 8’ high and 4’ across trimmed as space dictates with plywood as close to ceiling as possible. If the ceiling is over 8 feet in height then the plywood will be mounted as close to floor as possible not covering baseboard if present and will utilize the full 8 feet of the plywood.

B. Equipment Rack

1. Anchored to the floor with Hilti anchors.
2. The hardware is to be Grade 5 bolts with washers minimum.
3. The rack shall be plumb and level.
4. A vertical wire manager shall be on both sides of each rack.
5. Each rack having ladder rack attached to it will utilize a rack-to-runway kit.
6. Each rack will have a grounding bar.
7. Each rack will be grounded per industry standards.
8. Rack layout will be per industry standard, also verified with on site representative.

C. Cabinet

1. Attached to the wall with hardware rated for load of cabinet and of design for wall construction type. Toggle bolts to sheetrock in not acceptable.
2. The rack shall be plumb and level.
3. The rack is to be placed so the hinge open feature in not impacted in anyway and will have full range of operation.
4. Each rack will be grounded per industry standards.
5. Rack layout will be per industry standard, also verified with on site representative.

D. Ladder Rack

1. Ladder rack is to be installed per manufacturer recommendation for support.
2. Securely anchored to wall with wall termination bracket recommended by manufacturer.
3. Attached to racks with rack to runway kit as recommended by manufacturer.
4. Ladder rack to Ladder rack junctions will done with hardware whether it be “butt-splice” or “junction splice”.
5. Ladder rack that does not terminate at a will or into ladder rack i.e. floating end, will utilize an “end closing kit”.

E. Patch Panel

1. Need to allow for 10% expansion at the close of the project.

F. Horizontal Cable Managers

1. Provide cable mangers as shown in Rack Elevation Detail on the plans.
2. If no detail present on plans provide one horizontal manager above and below each patch panel.

G. Grounding

1. Each rack is to be grounded
2. Per TIA/EIA-607
3. Any part that has a painted surface will have a spot scraped in order to provide metal-to-metal contact for grounding. The spot scraped clean shall be visible with ground lug attached.

H. D-Rings

1. Every 2’
2. Placed at every turn in cable path to ensure a clean a professional install.
3. Rings shall used minimally to transition cable from wall mounted equipment to closest cable tray.

3.2 CABLES

A. All Cables within the Equipment room shall be routed to avoid any electrical interference.

B. D-rings if used for cable routing shall be sized to allow for future use.

C. Cables will be supported and secured in a professional manner.

D. Any Tie Cable passing through, within, or terminating in the space will be labeled with a To-From indication and pair count/strand count of cable. See section 17100 Cable Plant Overview for additional requirements.

END OF SECTION

PART 1 - GENERAL

1.1 DESCRIPTION

A. The Demarc/MPOE location for the utilities present for he building shall be indicated on the plans.

B. All requirements set by the appropriate Utility are to be met. If customer owned cable plant is entering the building both ends of the cable will be covered by this specification and industry standard for protection. See Section 17140 for additional requirements on Exterior Cabling.

C. All equipment, sleeves, bushing, fire-stop and accessories needed to make this a safe and useable area whether specified or not are to be a part of the contractor's submittals and implemented in the space.

1.2 QUALITY ASSURANCE

A. All equipment shall be UL listed. All installations shall comply with the NEC.

B. Refer to Specification 17010 for additional requirements.

C. Coordinate any work in this space with other trades that will be utilizing space in this area.

1.3 SUBMITTALS AND PRODUCT DATA

A. Include shop drawings depicting wiring and connection diagrams in addition to the requirements in other parts of this Specification.

PART 2 - PRODUCTS

2.1 MATERIAL

A. ¾"x 4' x 8' sheet of AC grade plywood. If utility requires use Fire-rated plywood.

B. Protector Entrance Terminal

1. 25, 50, or 100 pair capacity
2. Utilize 5-pin protectors
3. Factory wired and tested
4. 66 block distribution
5. 3M or approved Equal.

C. #6 AWG. Solid ground wire.

D. D-Rings

E. Conduit

F. Fire-Stop

G. Label Copper

1. Self-laminating cable marker holders
2. Panduit part SLCT or approved equal.

H. Label Fiber

1. Self-laminating fiber optic marker holder rigid tag
2. “Warning/Caution Fiber Optic” is to be manufacturer printed on the label.
3. Panduit part PST-FO or approved equal.

PART 3 - EXECUTION

3.1 EQUIPMENT ROOM

A. If fire-rated plywood is used it is to be attached with the stamp showing. The plywood is to be attached to the building structure, toggle bolts are not an acceptable means of support.

B. Conduits that are placed within the space that penetrate into adjacent areas will be done so in a way to maintain the Fire-Rating required.

C. Grounding is required to meet applicable codes and as required by Utilities. All Protection Entrance Terminals shall be grounded to main building ground.

3.2 CABLES

A. All Cables within the Equipment room shall be routed to avoid any electrical interference. Location of devices shown on plans are for reference only, they do not designate the layout of the space.

B. Cables are to be run through D-Rings leaving room for growth.

C. Cables will be supported and secured in a professional manner.

D. Any Cable-run through, within, or terminating in the space will be labeled with a To-From indication.

E. Any outdoor cable shall be spliced to interior grade within a proper sized splicing device within 50’ after leaving the conduit to comply with applicable codes.

PART 4 - DOCUMENTATION

4.1 LABELING

A. All cables terminating within the Equipment Room are to be labeled as close to where the cable sheath has been removed with the label still being visible.

B. Labeling will be done with a P-Touch or some other means of mechanical printing device.

C. Labeling that is used on the cables is to be the same as the labeling shown on the as-builts to be submitted at the end of the project.

D. All cable 25 pair or larger shall utilize the Self-laminating cable marker the marker shall have printed To-From locations and pair count by means of P-touch or other mechanical printing device.

E. All fiber optic cabling shall utilize the Self-laminating fiber optic marker tag, the marker shall have printed To-From locations and pair count by means of P-touch or other mechanical printing device. The tag shall be attached to the inner-duct, if over 5’ from leaving inner-duct to entering fiber optic shelf the fiber shall be labeled again just before entering shelf or other termination location.

END OF SECTION

PART 1 - GENERAL

1.1 DESCRIPTION

A. The interior communications pathways shall be in the most direct and efficient path possible. All conduits are to be sized so the cable load does not go beyond 40% fill. Cable paths shall be capable of future use and a string is to be left after cabling has been completed.

B. The Fire Rating of any structured penetrated during construction will be restored by the contractor who made the penetration.

C. All conduit stubs shall terminate with an end connector and plastic bushing. No cable path will have a junction box in a location that is not accessible after the project is complete. Only factory ells (no more than three) are allowed between junction boxes.

1.2 QUALITY ASSURANCE

A. Industry standards permit the use of EMT for installation of conductors in circuits rated below and above 600 volts, nominal, and in accordance with Article 348 of the National Electric Code.

B. The National Electric Code® (NEC®) establishes the minimum requirements for a safe electrical installation. Because of the varied environments in which electrical equipment is installed, local amendments are often added. Always consult local codes prior to any installation.

1.3 SUBMITTALS

A. Submit product data describing all equipment.

B. See Section 17010 for additional requirements.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Any Electric Metallic Tubing manufactured in accordance with the latest edition of the following:

1. American National Standards Institute - C80.3
2. Underwriters Laboratories Standard - UL 797
3. National Electric Code® 2002 - Article 358 (NEC® 1999 Article 348) Federal Specification - WW-C-563A

B. Caddy J-Hooks and supports

C. Cable Tray

1. FlexTray, Cablofil, Cable-Mgr, or approved equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Conduit

1. All conduits are to be installed with the most efficient route possible. No cable pathway will have more the 40% fill as recommended by the TIA/EIA Standards, verify cable load prior to installing conduit paths.
2. It is the responsibility of the contractor that is awarded the project to confirm the schedule for installation with the General Contractor.
3. Conduit paths shall terminate with end connectors and plastic bushings whether in junction boxes or stubs in accessible ceiling space.
4. Any penetrations made for the cable paths is the to be fire-stopped by the contractor who made the penetration.
5. Conduits will be installed and supported in a manner that meets or exceeds the requirements of the AHJ.
6. All voice/data outlets shall utilize a single gang mud ring with a 1” conduit. The conduit shall stub to accessible ceiling space and terminate with a plastic bushing at both ends for cable protection.
7. Voice/data outlets combined with ‘AV’ (audio/visual) will consist of a double gang mud ring with (2) 1” conduits. The conduits shall stub to accessible ceiling space and terminate with a plastic bushing at both ends for cable protection

B. Cable Tray

1. Cable tray is to be supported within 2’ of each splice for each piece with no more than 6’ between supports.

C. J-hooks

1. For best cable support J-hooks should be placed every 5 feet maximum and at corners as required for a clean and professional install.

D. Grounding

1. All interior pathways will be grounded per industry standard utilizing a continuous ground. If cable tray/ladder rack is painted a portion will have the paint removed to have the ground lug attached for metal-to-metal contact.

END OF SECTION

PART 1 - GENERAL

1.1 DESCRIPTION

A. Exterior communications pathways may either be underground or overhead which will dictate the type of cabling and support structures required.

B. All pole attachments, securing hardware and necessary devices are to be part of the contractors bid whether specified or not for a complete and safe install.

1.2 QUALITY ASSURANCE

A. All equipment shall be UL listed. All installations shall comply with the NEC.

B. Refer to Specification 17010 for additional requirements.

C. Refer to section 16 for additional requirements.

D. Standards as set by the BICSI Customer-Owned Outside Plant manual shall be followed as well.

1.3 SUBMITTALS AND PRODUCT DATA

A. Include shop drawings and cut sheets depicting splice cases, vaults, hand holes, and support items in addition to the requirements in other parts of this Specification.

B. The drawing submitted need to show the amount of space, mounting design, and any other requirements needed for the system submitted.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Allied Tube & Conduit, Western Tube & Conduit, Triangle, Bridgeport, AFC, Carlon, Western Plastics, Alflex, or approved substitute. Wiremold, Walker, or approved substitute.

2.2 CONDUITS

A. Galvanized Rigid Conduit (GRC) shall be hot-dip zinc, galvanized inside and out, mild steel pipe manufactured in accordance with UL-6 and ANSI C80.1. All threads shall be galvanized after cutting.

B. Electrical Metallic Tubing (EMT) shall be steel only and shall comply with UL-797 and ANSI C80.3. Exterior shall be hot-dip zinc galvanized and interior protected by a corrosion-resistant lubricating coating.

C. Intermediate Metallic Conduit (IMC) shall comply with UL-1242 and ANSI C80.6. Exterior shall be hot-dip zinc galvanized and interior protected by a corrosion-resistant lubricating coating.

D. Rigid non-metallic conduit (PVC) polyvinyl chloride shall be schedule 40 unless otherwise noted, and shall comply with UL-651 and NEMA TC 2.

E. Surface raceway shall utilize snap-in cover and fittings as recommended by the manufacturer and shall comply with UL 5 standard. Material and size shall be as indicated on the Drawings.

F. Flexible metal conduit shall be steel and comply with UL 1 and ANSI standards. Liquid-tight flexible metal conduit shall comply with UL 360 and ANSI standards.

PART 3 INSTALLATION

2.1 APPLICATION

A. Areas of use:

Underground	PVC
Within poured Concrete (except slab-on grade) or CMU	GRC, IMC, PVC
Dry concealed locations	GRC, IMC, EMT
Wet or Dry exposed locations, subject to damage	GRC, IMC
Dry exposed locations, not subject to damage	GRC, IMC, EMT
Hazardous Class I or II	GRC, IMC

B. Underground conduit shall be minimum 3/4" trade size. PVC shall not be used inside building. Unless otherwise approved, all conduits shall be installed under reinforcing steel.

C. For the purposes of this section, poured concrete slabs on grade and under-the-building slabs are not classified as dry locations.

D. Flexible metal conduit will be permitted only where flexibility is necessary. Flexible metal conduit shall be used for connection to all equipment subject to movement or vibration. Liquid-tight flexible metal conduit shall be used when moisture may be present and for exposed motor and equipment connections.

E. Surface raceway may be used only where specifically called for on the Drawings or in the Specifications.

F. Aluminum conduit is not permitted.

END OF SECTION

PART 1 - GENERAL

1.1 DESCRIPTION

A. Backbone cabling will consist of riser raterd fiber optics and copper.

B. All equipment, sleeves, bushings, fire-stop and accessories needed to make a complete and functional system are to be a part of the bid whether specifically stated in the specification, shown on plans or not.

1.2 QUALITY ASSURANCE

A. All equipment shall be UL listed. All installations shall comply with the NEC.

B. Refer to Specification 17010 for additional requirements.

C. Coordinate any work in this space with other trades that will be utilizing space in this area.

D. System Installers

1. Shall have no less than 3 years of documented work experience on projects of equivalent size and technical difficulty. If you are using a Subcontractor their installers must meet the requirements, this is a requirement of the installer not the bidder.
2. “Experience” is defined as the completion of an operational system, with the system being successfully operated by the customer for its intended purpose for at least one year.
3. Must have current certification, from the Manufacturer, on the system to be installed

E. Comply with BISCI Customer-Owned Outside Plant recommendations.

1.3 SUBMITTALS AND PRODUCT DATA

A. Include shop drawings depicting wiring and connection diagrams in addition to the requirements in other parts of this Specification.

B. The drawing submitted need to show the amount of space, mounting design, and layout of the proposed system.

C. Submit cut sheets on cable, splice cases, and all support pieces for the installation.

PART 2 - PRODUCTS

2.1 MATERIAL

A. Copper

1. 25 or 50 pair as indicated on plans.
2. Category 3 cable.
3. The cable jacket shall be riser rated.

B. Fiber Optic

1. 12 strand 50/125.
2. The jacket of the fiber optics shall be riser rated.

C. Protector Entrance Terminal

1. All copper cable run exterior of a building will utilize a protector when entering the building.

D. Splice Case

1. All exterior grade gel filled cabling will splice to interior grade cabling when entering the building per code requirements.

PART 3 - EXECUTION

3.1 CABLES

A. All Cables within the Equipment room shall be routed to avoid any electrical interference. Location of devices shown on plans are for reference only, they do not designate the layout of the space.

B. Cables are to be run through D-Rings leaving room for growth.

C. Cables will be supported and secured in a professional manner.

D. Any Cable-run through, within, or terminating in the space will be labeled with a To-From indication.

E. Copper tie cables will be left with a 10’ service loop at each end. Loop will be located to have as little impact of space as possible while still readily available if needed.

F. Fiber will have a 30’ service loop at each end. Loop will be located to have as little impact of space as possible while still readily available if needed.

G. Cables will terminate per either 110 block, 66 block, or patch panel. A cable indication tag will be placed before termination easily visible indicating From location and cable/fiber grade.

H. Cable and fiber will get a service loop at each vault along it path. The loop will be once around the vault and will supported above water line in the vault. Each loop will be tagged with a cable identification tag indicating To-From locations, strand or pair count, and grade or cable i.e. 62.5/125 or category.

I. The fiber will terminate in a Fiber Shelf at both ends by means requested on plans. The fiber end connector will be as requested on plans.

PART 4 - DOCUMENTATION

4.1 LABELING

A. All cables terminating within the Equipment Room are to be labeled at the termination point and within 6” of the end of the cable on the sheath.

B. Labeling will be done with a P-Touch or some other means of mechanical printing device. Labeling that is used on the cables is to be the same as the labeling shown on the as-builts to be submitted at the end of the project.

END OF SECTION

PART 1 – GENERAL

1.1 DESCRIPTION

A. Horizontal cabling will consist cable less than 25 pair from Network/IT/Equipment Rooms out to station outlets, camera's, wall phone, or wall/ceiling-mounted devices.

B. Fiber optics may be used as part of Horizontal Cabling System. If installed all fiber will utilize Inner-duct for additional protection. The Inner-duct is to route as close to the termination location as possible.

C. Provide all jumper management, D-Rings, J-hooks, voice blocks and accessories needed for a complete and professional installation.

D. All equipment needed for a complete install whether specified directly or not to properly route, terminate, and test the Horizontal Cabling is to be part of the bid.

1.2 QUALITY ASSURANCE

A. The vendor shall comply with the following standards and codes:

1. National Electrical Code.
2. See Section 17010 for additional requirements.
3. UL Listed.

B. Additional requirements listed in 17010.

C. System Installers
1. Shall have no less than 3 years of documented work experience on projects of equivalent size and technical difficulty. If you are using a Subcontractor their installers must meet the requirements, this is a requirement of the installer not the bidder.
2. "Experience" is defined as the completion of an operational system, with the system being successfully operated by the customer for its intended purpose for at least one year.
3. Must have current certification, from the Manufacturer, on the system to be installed

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. The district approved manufacturer is Leviton.

B. Cable manufacturer must comply with termination hardware, cabling submitted must provide and end-to-end solution.

2.2 MATERIALS

A. Cable

1. Category 5e for both voice and data cabling.
2. Part of the Structured Cabling

3. Color has been indicated on plans. If no color indicated on plans verify with architect prior to purchase.
4. The cabling shall be riser rated.

B. Patch Panels

1. Category 3 and Category 5e depending on the purpose, verify with plans.
2. Universal pin-out
3. Part of the Structured Cabling System.

D. Faceplates/Wall box

1. Will fit industry standard junction boxes whether single or double gang, style will be indicated on plans.
2. Blank for any used ports.
3. Color will be set by Architect.
4. Any outlet with Fiber Optic port will have a “Warning Fiber Optic” label visible.

E. Jacks

1. Universally wired for 568A or 568B.
2. Must be compliant with TIA/EIA Requirements.
3. Non keyed style design.
4. Color dependant on system utilizing the jack. Color shall be indicated on plans if no color shown verify with architect prior to purchase.

F. Fiber Optic Jack

1. Style shall be dictated by fiber grade, as indicated on plans.
2. Termination shall be epoxy style field polish.
3. Single or duplex as indicated on plans or by style of outlet.

G. Innerduct

1. Color shall be dictated by type or as indicated on plans.
2. Grade shall be per ceiling type whether plenum or not. Verify prior to purchase.

PART 3 - INSTALLATION

3.1 CABLES

A. All Cables within the Equipment room shall be routed to avoid any electrical interference. Cable that route from wall-mount equipment shall utilize D-rings to get to the closest cable tray. All cables within Data/IT/Equipment Room shall be dressed and neatly bundled utilizing velcro cable ties

B. If D-Rings are used be sure to size them leaving room for growth.

C. Cables in ceiling space will be supported every 5’ minimum and secured in a professional manner. If cable tray is available cables utilizing the tray will be separated by system and loosely bundled with velcro cable ties.

D. The interior communications pathways shall be in the most direct and efficient path possible. Cables are to be bundled and share a common path whenever possible. Size J-hooks for appropriate load and follow manufacturer recommendation for fill. Cables shall not be laying on ceiling tiles or using other systems i.e. electrical conduit, plumbing pipe, HVAC duct for support.

E. Approx. 12” to 16” of slack left supported above ceiling before entering the conduit at the station end.

F. Small slack loop left at the Equipment Room/IT/Data Room.

G. Follow manufacturer recommendation for pulling tension and bend radius.

3.2 TERMINATION

A. Termination in IDF/MDF will be based on type of cable and system utilizing the cable. The termination equipment type and location shall be indicated on the plans. Verify proper pin-out with onsite IT staff, whether 568A or 568B, prior to termination.

B. Station side will be verify pin-out prior to termination. Termination of cables will be sequential as numbered for ease of outlet identification. Verify labeling style with plans or onsite Owner Representative.

END OF SECTION

PART 1 - GENERAL

1.1 DESCRIPTION

A. All testing and identification is to be complete 100% testing.

B. Documentation is to cover all parts of the cabling system, equipment, and locations.

1.2 QUALITY ASSURANCE

A. All labels are to match from cable to outlet to As-Builts.

B. All labels are to be made by means of a permanent printable label.

C. See Section 17010 for additional requirements.

D. Code Requirements

1. BISCI TDMM, Latest edition
2. TIA/EIA-606 Administration Standard for Commercial Telecommunications Infrastructure
3. TIA/EIA 568B.2-1 (all addendums)
4. TSB-72
5. ANIS/TIA/EIA-568-A (all addendums)

1.3 SUBMITTALS

A. Submit product data for all equipment to be used for testing and labeling.

B. Submit shop drawings indicating style of label you will be using in which situations and what numbering system you plan on using.

C. As a part of the submittals you need to show a copy of the certification of the tester(s) you will be using to test the cables/fiber at the close of the project. The tester(s) must have been certified within one year of the project. The tester is to be certified for the level of cable that is to be tested.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Any manufacturer of tester that meet the current Category 6 test parameters. Electronic copy of tests shall be nonproprietary so they may be viewed on any PC based system with out having to load the test manufacturers software.

B. Fiber optic testers
1. Including but not limited to OTDR and Power Meter

PART 3 - TESTING AND ADMINISTRATION

3.1 TESTING

A. Testing will be completed per Industry Standard for cable type to be tested. TIA/EIA-568-B.1 (category 5e) and TIA/EIA-568-B.2-1 (category 6)
ISO/IEC 11801:2002 2nd Edition (classes D, E and F)

B. Structured cabling tests to include but not limited to:

1. NEXT, next @ remote
2. Wire map
3. Characteristic impedance
4. Length
5. DC loop resistance
6. Propagation delay
7. Return loss (rl), rl @ remote
8. Delay skew
9. Attenuation
10 Attenuation-to-crosstalk ratio (acr), acr @ remote.
11. Power sum acr, psacr @ remote
12. ELFEXT, elfext @ remote
13. Power sum elfext, pselfext @ remote
14. Power sum next, psnext @ remote

C. Tie Cable Testing

1. Wire-map
2. Length
3. Cable faults

D. Fiber Testing

1. Power Meter One way
2. OTDR Bi-directional
3. Test at 850 & 1300
4. Must meet acceptance values as stated by ANSI/TIA/EIA-568-B.1

E. All Testing

1. All systems to be 100% tested

3.2 DOCUMENTATION

A. Tests that generate a report

1. Will be printed and submitted in a 3-ring binder with plastic sleeves in numeric or alphabetic order.
2. Electronic copy on 3.5” Floppy Disk in a nonproprietary format. Tests can be viewed in Word Pad, Note Pad or some other word processing software.
3. Printed test page information will include but not limited to:
   a. NEXT, next @ remote
   b. Wire map
   c. Characteristic impedance
   d. Length
   e. DC loop resistance
   f. Propagation delay

g. Return loss (rl), rl @ remote
h. Delay skew
i. Attenuation
j. Attenuation-to-crosstalk ratio (acr), acr @ remote.
k. Power sum acr, psacr @ remote
l. ELFEXT, elfext @ remote
m. Power sum elfext, pselfext @ remote
n. Power sum next, psnext @ remote

B. Tests that do not generate a report.

1. Give 1 week written notice, to the Owner Representative, of test day so they may witness the tests.
2. Test results are to be documented on a test form generated by the testing company and submitted with the other tests on testing company letterhead. The test results are to be organized and typed in a professional manner that can be clearly understood by the owner with out any interpretation by the testing company.

3.3 ADMINISTRATION

A. Plans

1. Indicate for all systems
   a. Equipment list for all locations
   b. Connections
   c. Cable Routes
   d. Station Identification exactly as show on outlet.

B. Documentation

1. Printed documents for each individual jack will be printed and submitted in a 3-ring binder with plastic sleeves in numeric or alphabetic order. Binder cover page will state testing company, date tested, project identification and system test results contained. One cable test per page.
2. Electronic copy on 3.5” Floppy Disk in a nonproprietary format. Tests can be viewed in Word Pad, Note Pad or some other word processing software.

C. Labeling

1. Labeling will be done by means of a mechanical device i.e. printer, P-Touch, or other printing device. Hand written labels are not acceptable. If label holder is present on faceplate labels are to be placed into this area, if not they are to be securely attached to the faceplate. Labels will be black on white or as requested by architect, verify prior to labeling.
2. Numbering is to be sequential per faceplate and per room for ease of identification by owner. Verify labeling scheme to be used with owner representative one week prior to starting to, so there will be no delay to project while obtaining an answer.
3. Number between faceplate and patch panel or faceplate and voice equipment is to match.

END OF SECTION

PART 1 - GENERAL

1.1 DESCRIPTION

A. The conditions of the General Contract (General, Supplementary, and other Conditions) and the General Requirements are hereby made a part of this Section.

B. All bids shall be based on the equipment as specified herein.

C. Furnish and install all equipment, accessories, and materials in accordance with these specifications and drawings to provide a complete and operating integrated Intercom System consisting of Telephone, Intercommunication, Public Address System and Time Control System.

D. The intercom system is to be fully compatible with the O.F.O.I. telephone system.

1.2 SUBMITTALS

A. Specification sheets shall be submitted on all items including cable types.

B. Submit outline drawing of system control cabinet showing relative position of all major components.

C. Submit FCC registration number on separate documentation with the ringer equivalency of the proposed integrated telephone system. This documentation is mandatory, all submittals without FCC registration information will automatically be rejected.

D. Submit wiring diagrams showing typical connections for all equipment.

E. Submit a certificate of completion of installation and service training from the system manufacturer.

1.3 SERVICE AND MAINTENANCE

A. The contractor shall provide a one year warranty of the installed system against defects in material and workmanship. All labor and materials shall be provided at no expense to the owner during normal working hours. The warranty period shall begin on the date of acceptance by the owner/engineer.

B. The contractor shall, at the owner's request, make available a service contract offering continuing factory authorized service of this system after the initial warranty period.

C. The system manufacturer shall maintain engineering and service departments capable of rendering advice regarding installation and final adjustment of the system.

1.4 QUALITY ASSURANCE

A. All items of equipment including wire and cable shall be designed by the manufacturer to function as a complete system and shall be accompanied by the manufacturer's complete service notes and drawings detailing all interconnections.

B. The contractor shall be an established communications and electronics contractor that has had, and currently maintains, a locally run and operated business for at least five years. The

contractor shall be a duly authorized distributor of the equipment supplied with full manufacturer's warranty privileges.

C. The contractor shall show satisfactory evidence, upon request, that he maintains a fully equipped service organization capable of furnishing adequate inspection and service to the system. The contractor shall maintain at his facility the necessary spare parts in the proper proportion as recommended by the manufacturer to maintain and service the equipment being supplied.

D. EIA Compliance: Comply with the following Electronics Industries Association Standards:

1. Sound Systems, EIA-160.
2. Loudspeakers, Dynamic Magnetic Structures, and Impedance, EIA-299-A.
3. Racks, Panels, and Associated Equipment, EIA-310-A.
4. Amplifiers for Sound Equipment, SE-101-A.
5. Speakers for Sound Equipment, SE-103.

1.5 SINGLE SOURCE RESPONSIBILITY

A. Except where specifically noted otherwise, all equipment supplied shall be the standard product of a single manufacturer of known reputation and experience in the industry. The supplying contractor shall have attended the manufacturer's installation and service school. A certificate of this training shall be provided with the contractor's submittal.

1.6 SAFETY / COMPLIANCE TESTING

A. The communication system supplied shall be listed by Underwriter's Laboratories under UL Standard 1459. A copy of the UL listing card for the proposed system shall be included with the contractor's submittal.

1.7 WIRING

A. System wiring and equipment installation shall be in accordance with good engineering practices as established by the EIA and the NEC. Wiring shall meet all state and local electrical codes. All wiring shall test free from all grounds and shorts.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Approved Manufacturers:

1. Rauland-Borg, Dukane, Bogen, or approved equal.

2.2 SYSTEM REQUIRMENTS

A. General: The system shall provide the state of the art in technology for all internal telephone and intercom communications, secondary clock corrections, and bell schedule. All standard system programming shall be user friendly to allow the system administrator the ability to easily program system features.

B. Provide complete and satisfactorily operating Integrated Intercom/Communications System as described herein, using materials and equipment of types, sizes, ratings, and performances as indicated. Coordinate the features of all materials and equipment so they form an integrated

system, with components and interconnections matched for optimum performance of specified functions.

C. Features offered by this system shall be implemented and controlled by software programs that can be changed and expanded as customer needs evolve.

D. The system shall allow system monitoring and administration from a local Windows PC or remote Windows PC via a modem.

E. The system shall be an electronic system consisting of one or two amplified intercom channels, speakers, horns, digital readout for display of call origination, and solid state logic and sensing.

F. Ability to provide multiple zone program distribution which is not interrupted by intercom communications.

G. The system shall lend itself to expansion by simple addition of modules.

H. The central switching system shall provide for switching of the intercom talk path to a telephone mode, during the course of a call.

I. The system shall be equipped with voice prompting to identify the calling station and respective call priority.

J. Two-way telephonic communication capability from any classroom phone to any administrative phone.

K. Two-way communication between any telephone and any room speaker.

L. Room speakers shall be programmable and may be assigned any three, four or five digit number. Any room number may be reassigned at any time, and it shall not be dependent on wiring or circuit numbers.

M. Separate paging zones shall be provided; each location shall be programmed in software to belong to any combination of software zones. Zones shall be provided as requested by the owner. Each classroom will be a zone, general public spaces and interior corridors will be a zone, zone for exterior speakers, and a zone for the gymnasium.

N. Each dialing administrative telephone in the system shall be programmable for the following options:

1. Allow zone paging.
2. Allow All-Page announcements.
3. Allow Executive Override.
4. Allow Emergency paging.
5. Allow activation of Time Zone tones.
6. Set the priority level and target display of "normal" calls.
7. Set the priority level and target display of "emergency" calls.
8. Assignment of architectural number.
9. Class of Service.
10. Assignment of associated speaker to paging zone.
11. Automatic Call-Back-Busy.
12. Call Forward-No Answer.
13. Call Forward-Busy.
14. Allow activation of security monitoring functions on a per room and per zone basis.

O. Amplified two-way voice communication shall be available from any dial phone in the system, through any speaker in the system. This shall allow hands-free communication to any classroom or any individual loudspeaker unit. A programmable pre-announce tone shall sound immediately before the intercom path is opened and a supervisory tone shall continue to sound at regular intervals when speaker monitoring is active.

P. The administrative phones shall be located in the office and where indicated on the plans; these phones instruments shall be used for public and inter-school communication.

Q. The system shall allow room or area security monitoring features. This will include the ability to support motion detectors or normally open alarm inputs.

R. Ability to play music from multiple sources (turner, cd, MP3, Ipod) which will suspend when voice announcements are being made.

2.3 EQUIPMENT AND MATERIALS

A. Central Controller Unit: The Integrated Electronic Communications Network shall have the following capabilities:

1. Facilities for multiple operations simultaneously without interference with an established pattern of priorities for all administrator/classroom communication capabilities.
2. Facilities for centralized attendant answering.
3. The system shall provide Personal Identification Numbers for selected administrators. By dialing their PIN at any system telephone, the administrator shall have access to the same intercom/paging capabilities assigned to their office telephone, regardless of the restrictions on the phone they are currently using.
4. Provide multiple attendant positions for answering outside lines and internal intercom calls.
5. Facilities for the central control unit to store information and give reports on features, system activity, etc. upon request either on site or remotely.
6. Facilities for automatically sounding a warning tone signal over any loudspeaker selected for two-way communications to alert the station attendant (classroom teacher) to the call and prevent unauthorized monitoring.
7. Facilities for access to any single loudspeaker unit, zone loudspeaker unit, or all loudspeaker units. The warning tone signal shall sound as soon as the station is selected and shall be automatically repeated at regular intervals for the duration of the call if the voice circuit is not activated.
8. Direct Dialing, two-way amplified voice intercom between all locations equipped with administrative telephones and staff station speakers without the use of a press-to-talk or talk-listen switch.
9. The Central Controller Unit shall provide an RS-232 port for the connection of on-site or off-site diagnostics by distributor or factory-trained personnel.
10. Facilities for executive override permitting an assigned telephone to "override" on-going intercom conversation(s) in the system.
11. Facilities for the instantaneous distribution of emergency announcements simultaneously, by a single button access, to all locations equipped with speakers.
    a. Emergency announcements originating from any assigned administrative telephone shall have priority over all regular system functions.
12. Facilities for the distribution of alarm signals to all areas equipped with speakers by single button access.
    a. Up to nine (9) separate distinct alarm signals shall be provided. Each of the distinct alarm signals can be activated by a designated single button.
13. Capability for assigning speaker locations to any one or more of the sixteen (16) zones for zone paging, up to sixteen (16) zones for program distribution, eight (8) zones for

class change “bells”, and up to eight (8) security zones. All of these zones may be configured to be independent of the other zones.

14. Facilities for the origination of both “normal” and “emergency” calls from any staff location. Calls may originate from either a separate call switch or by going off hook on the Staff Phone.
15. It shall be possible to review all calls stored in memory in the order received.
16. Facilities for answering calls registered in the digital read-out display merely by pressing a single response button. This capability shall not prevent other calls from being placed or answered by dialing their numbers.
17. Facilities to cancel all staff station originated calls from any administrative telephone.
18. Facilities for assigning or changing classroom numbers by architectural or any desired numbering system; either three-digit, four-digit, or five-digit numbers may be assigned.
19. Facilities for multiple loudspeaker or telephone conversations to take place and not prevent announcements, educational, or music programs from being distributed to other areas of the building.
20. Facilities to automatically send incoming calls to an alternate phone or if they remain unanswered for a predetermined amount of time.
21. A facility to notify a user that the intercom path called earlier is now available. If a busy signal is obtained, user shall dial callback feature code and hang up. System shall automatically call back user when intercom path is available and complete an intercom call to speaker.
22. Facilities for universal wiring for all data network, telephones, intercom speakers, and call switches using category 5 cable.
23. Facilities to provide automatic emergency instructions to be broadcast to the entire school when an alarm is tripped. The emergency instructions are preprogrammed and require no user intervention.
24. Facilities for single button access to allow page announcements into speaker zones without interrupting others performing simultaneous functions.
25. Facilities to page one or more area-wide pocket pagers when a call is placed of a specific call priority or all call priorities. The pocket pager will display the calling room number and a numeric call priority.
26. Facilities to automatically alter a call switch’s class of service by time of day and day of week as directed by the owner.
27. It shall be possible to initiate Class of Service changes either manually or automatically on a per station basis using internal clock set.
    a. A minimum of four independent program memory sets shall be provided.
    b. Choice of time of service change and active memory set selected shall be completely programmable.
        1) Class of Service Changes shall be programmable by time of day and day of week.
        2) A minimum of 64 unique classes of service shall be available.
28. Capability for assigning speaker locations to any one or more of the zones for zone paging or time signal reception; this assignment to be a programmable function.
29. Time signal tones shall be generated on a manual or automatic basis.
30. Emergency tones shall be distributed from designated Administrative Telephones.
31. Power amplifiers shall meet all specifications exactly as specified herein, including power capacity and count.

B. Switchpanel:

1. Program distribution shall be controlled by both dial-up or switch panel selection for individual speakers or program distribution zones. Systems not providing for both switch panel AND dial-up program distribution will not be acceptable.
2. Speaker stations may be manually accessed by rack-mounted switch-panels specifically designed for individual and/or group station selection.

C. Program Distribution System:

1. The system shall provide facilities to distribute program material (i.e. cassette tape, CD, radio broadcasts) in the following manner:
   a. The media operator shall cue remotely located music source or select radio station.
   b. The media operator shall then "direct select" room(s) or areas to send the program via a switchpanel or the media operator shall dial from an Administrative Telephone to select the room(s) or areas to distribute program.
   c. Both means of switch panel and dial-up program distribution shall be accessible from the system.
2. Power amplifiers shall meet all specifications exactly as specified herein, including power capacity and count, provide a minimum of ½ watt power to all intercom speaker locations plus 15 watts power to all horn type speaker locations.

D. Time Programming: The master time controller shall provide the following functions:

1. Non-volatile memory capacity for storing 550 events and up to 100 Calendar dates fore schedule changes.
2. Ability to review, edit and delete events via a Windows 98 or newer PC running the configuration program.
3. Review events from any entered time of day.
4. Events shall be programmable to any or all of (8) zone circuits.
5. Selection of any of (8) schedules to allow flexibility due to seasonal changes or special events.
6. Fully automatic Calendar execution.
7. User programmable Automatic Daylight Savings Time Change.
8. Programmable Music-on-Class-Change. This feature shall be programmable from 1 to 3600 seconds (60 minutes).
9. Separate bell-tone selection and separate bell duration for each event.
10. Latched operation of zones to control lighting or other devices.
11. Interface with most types of secondary slave clocks whether synchronous wired or electronic.
12. User-programmable custom slave clock correction. Output relays rated at 5 amperes shall be provided on all zone circuits as necessary.
13. Lithium battery will provide not less than 5 years battery back-up for timekeeping function.

E. Classroom Security and Supervision Interface:

1. Each classroom connected to the intercom system shall offer the ability to interface to a security transducer-like motion detector or door switch.
2. All field wiring shall be individually supervised for opens or shorts to each call station and security devices.
3. No other wiring or equipment shall be needed to secure a classroom.
4. Arming and disarming functions shall be performed by dial-up via the Administrative Telephone(s).
5. Easy interface shall be provided to the main security system.
6. Any systems not providing inherent security functions in the classrooms shall not be acceptable.

F. Data Logging:

1. System wide events. The System Log shall contain all events that occurred in the system for which event logging has been enabled to diagnose or document system usage.

2. Schedule parameters. Shows for each day-of-the-week the times-of-day when system configuration modes change.
3. System logging. The System Log Dump report shall list all events that occurred in the system for which event logging has been enabled to diagnose or document system usage.
4. System shall be self-monitoring. System shall include a background process dedicated to self-monitoring.

G. Accessories:

1. Area speaker volume control. 10 watt, 10 step plus 'off': Stainless steel plate.
2. Exterior Speaker.
   a. Reentrant type.
   b. Frequency Response: 350 to 10,000 Hz.
   c. Power Handling: 1 Watts to 16 Watts Peak.
   d. Variable screw taps, 25 V and 70 V line matching transformer.
   e. Mounting: Recessed, provide necessary back box.
   f. Color: White, finish to architects request.
   g. Rauland ACC1411 or approved equal.
3. Interior intercom/paging - talkback speaker:
   a. 8" cone
   b. Frequency response: 65 to 17,000 Hz.
   c. Power handling: 1/2 watts to 5 watts peak.
   d. Variable screw taps, 25 V and 70 V line matching transformer.
   e. Sensitivity: 93 dB at one meter with 1-watt input.
   f. Mounting: Recessed ceiling mount, provide necessary bridge and backbox.
   g. Color: White
   h. Rauland ACC1400 or approved equal.
4. Interior paging speaker with integrated volume control
   a. 8" cone
   b. Frequency response: 65 to 17,000 Hz.
   c. Power handling: 1/2 watts to 5 watts peak.
   d. 50-ohm potentiometer
   d. Variable screw taps, 25 V and 70 V line matching transformer.
   e. Sensitivity: 93 dB at four feet with 1-watt input.
   f. Mounting: Recessed ceiling mount, provide necessary bridge and backbox.
   g. Color: White
   h. Rauland ACC1403 or approved equal.
5. Gymnasium enclosed speaker
   a. 8" cone
   b. Frequency response: 60 to 17,000 Hz.
   c. Power handling: 1/2 watt to 5 watts peak.
   d. 10 watts RMS power rating
   d. Variable screw taps, 25 V and 70 V line matching transformer.
   e. Sensitivity: 95 dB at four feet with 1-watt input.
   f. Mounting: Surface mount provide necessary backbox.
   g. Color: White, paint to finish as requested by architect.
   h. Rauland ACC1403 or approved equal.
6. Speaker mounting or housing
   a. Provide bridge, baffle, and back box as required for mounting location.

H. Equipment Racks:

1. Equipment racks shall be located in a climate-controlled area/room as shown on drawings. Equipment racks shall be:

a. Self-contained, specifically engineered racks with provisions for all present and future components as described and recommended by the manufacturer within this specification.
b. Racks shall be accessible from front and rear.
c. All program, zone, and time circuitry, data, linkage, power, telecommunications components, and circuitry to be located in racks configured as approved by the Engineer.

I. AM/FM/CD Control Center

1. Panel mounted AM/FM/CD player
2. Tuning range of AM is 530 – 1710kHz, FM range is 87.9 – 107.9 mHz.
3. Control panel of the radio/CD player displays the frequency of the statioin currently tuned, FM or AM band, if it is a stereo broadcast, and the present station number.
4. Other front panel controls include volume, balance, tone, and auto seek and scan.
5. Play CDs, CD-Rs and CD-RW discs, including discs loaded with MP3, WMA, and AAC files.
6. CD frequency response: 10-20,000 Hz, CD signal-to-noise ratio: 110 dB, FM sensitivity: 9.3 dBf.
7. An LED bar display shall be located on the front panel for visually monitoring system volume levels.
8. The control center whether with connections on the front panel or supplied and attached cables will have the ability to broadcast MP3 and Ipod music.
9. Both F-type and banana-type female plugs shall be provided for connection to an AM/FM antenna.

J. Cables: 18 AWG single or 2 pair twisted, shielded, two pair twisted CAT 5e.

PART 3 – EXECUTION

3.1 EXAMINATION

A. Examine conditions, with the Installer present, for compliance with requirements and other conditions affecting the performance of the Integrated Electronic Communications Network system.

B. Do not proceed until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. General:

1. Install system in accordance with NFPA 70 and other applicable codes. Install equipment in accordance with manufacturer's written instructions.

B. Wiring Methods:

1. Install wiring in raceway except within consoles, desks, and counters, and except in accessible ceiling spaces. Use UL listed plenum cable in environmental air spaces including plenum ceilings.

C. Impedance and Level Matching:

1. Carefully match input and output impedance's and signal levels at signal interfaces. Provide matching networks where required.

D. Control Circuit Wiring:

1. Provide number of conductors as recommended by system manufacturer to provide control functions indicated or specified.
2. The contractor shall mount a main distribution frame behind the Integrated Electronic Communications Network console. All wires shall be laid down on terminal punch blocks and identified by the actual room location it serves. All the communications points shall be wired into this main distribution frame, laid down in sequence, and identified by which line it is on and the point position it serves.
3. All housings are to be located as specified and shown on drawings.
4. Make installation in strict accordance with approved manufacturer's drawings and instructions.

E. Wiring Within Enclosures:

1. Provide adequate length of conductors. Bundle, lace, and train the conductors to terminal points with no excess. Provide and use lacing bars.
2. Provide physical isolation from each other for speaker-microphone, line-level, speaker-level, and power wiring. Run in separate raceways, or where exposed or in same enclosure, provide 12 inch minimum separation between conductors to speaker-microphones and adjacent parallel power and telephone wiring. Provide physical separation as recommended by equipment manufacturer for other Integrated Electronic Communications Network system conductors.

F. Splices, Taps, and Terminations:

1. Make splices, taps and terminations on numbered terminal punch blocks in junction, pull, and outlet boxes, terminal cabinets and equipment enclosures, only. Midline splices are not acceptable.

G. Identification of Conductors and Cables:

1. Use color coding of conductors and apply wire and cable marking tape to designate wires and cables so all media are identified in coordination with system wiring diagrams.

H. Weatherproofing:

1. Provide weatherproof enclosures for items to be mounted outdoors or exposed to weather.

I. Repairs:

1. Wherever walls, ceilings, floors, or other building finishes are cut for installation , repair, restore, and refinish to original appearance.

3.3 GROUNDING

A. Provide equipment grounding connections for Integrated Electronic Communications Network systems as indicated. Tighten connections to comply with tightening torques specified in UL Standard 486A to assure permanent and effective grounds.

B. Ground equipment, conductor, and cable shields to eliminate shock hazard and to minimize to the greatest extent possible, ground loops, common mode returns, noise pickup, cross talk, and

other impairments. Provide 5-ohm ground at main equipment location. Measure, record, and report ground resistance.

C. The contractor shall furnish and install a dedicated, isolated earth ground from the central equipment rack and bond to the incoming electrical service ground buss bar.

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Services:

1. Provide services of a duly factory authorized service representative for this project location to supervise the field assembly and connection of components and the pre-testing, testing, and adjustment of the system.

B. Inspection:

1. Make observations to verify that units and controls are properly labeled, and interconnecting wires and terminals are identified. Provide a list of final tap settings of paging speaker line matching transformers.

C. Testing:

1. Rectify deficiencies indicated by tests and completely re-test work affected by such deficiencies at Contractor's expense. Verify by the system test that the total system meets the Specifications and complies with applicable standards.

3.5 COMMISIONING

A. Train Owner's maintenance personnel in the procedures and schedules involved in operating, troubleshooting, servicing, and preventative maintenance of the system. Provide a minimum of 4 hours training. Operators Manuals and Users Guides shall be provided at the time of this training.

B. Schedule training with Owner through the Architect, with at least seven days advance notice.

3.6 OCCUPANCY ADJUSTMENTS

A. When requested by the Architect within one year of date of Substantial Completion, provide on-site assistance in adjusting sound levels, resetting matching transformer taps, and adjusting controls to suit actual occupied conditions. Provide up to three visits to the site for this purpose.

3.7 CLEANING AND PROTECTION

A. Prior to final acceptance, clean system components and protect from damage and deterioration.

END OF SECTION

The following **SURFACES, MATERIALS, FINISHES or PAINT SYSTEMS,** and **COLORS** are **typical** unless noted elsewhere in the Contract Documents.

Notes:

1. Where **"TBS"** (*To Be Selected*) is shown in reference to a Factory Finish, the Product Color is to be selected by the Architect from the Manufacturer's full available Color Selections, unless noted otherwise elsewhere in the Contract Documents.
2. Field verify locations of all paint colors listed below with the Architect prior to initiating painting.

SURFACE	MATERIAL	FINISH or PAINT SYSTEM	COLOR
Roofing	Composition	Factory	Weathered Wood
Roof Flashing	Metal	Factory	Hemlock Green
Sky Light	Translucent Panel	Factory	Opaque White
Skylight Flashing and Trim	Aluminum	Factory	Dark Bronze
Fascia	Metal	Factory	Hemlock Green
Soffit and Trim	Metal	Factory	Parchment
Wall Siding and Trim (except accent bands)	Metal	Factory	Parchment
Louvers	Metal	PS-2	Hemlock Green
Louver Trim	Metal	Factory	Hemlock Green
Door / Window Trim, Accent bands.	Metal	Factory	Hemlock Green
CMU below 2'-8"	Split-Face CMU	Factory / Seal with Anti-graffiti.	Cream (Type 2)
CMU above 2'-8"	Smooth -Face CMU	Factory / Seal with Anti-graffiti.	Cream (Type 3)
CMU accent bands/sills	Smooth Face CMU	Factory / Seal with Anti-graffiti.	Charcoal (Type 4)
Wall Ball Wall	Smooth CMU	Factory / Seal with Anti-graffiti.	Match Building colors with Bull-nose colors.
Trash/Mechanical Enclosure	Smooth CMU	Factory / Seal with Anti-graffiti.	Match Building colors.
Mortar at CMU	Cement	Factory	Natural
Windows	Aluminum	Factory	Dark Bronze

Alum. Entrance System	Aluminum	Factory	Dark Bronze
H.M. Doors and Frames	Metal	PS-2	P2
Misc. Flashing/ Downspout	Metal	Factory	Match Hemlock Green
Sealants	Specification	Factory	Match Lighter Color of Adj. Materials – Verify with Architect
Gutters	Metal	Factory	Match Hemlock Green
Downspouts	Metal	Factory	Match Hemlock Green
Rooftop Vents and Mech. Equipment	Metal / PVC	PS-2	P9
Rooftop equipment platform	Metal	PS-1	P9
Bollards	Metal	PS-1	TBS
Gas Meter	Metal	PS-1	TBS
Monument Sign Frame	Metal	PS-2	TBS
Traffic Gates	Metal	PS-2	TBS
Trash / Mech. Enclosure gates	Vinyl Slats	Factory	TBS
Chain Link Fencing	Galv. Steel	Pre-finished	
Misc Metal		PS-1	Match Color of Adjacent Materials
Detectable Warning at raised crosswalk	Concrete	Colored Concrete	TBS
All Other Exposed Materials		Consult with Architect for Finish and Color	

END OF SCHEDULE

General Interior Finish Notes:

1. All exterior aluminum doors and storefront frames shall be Bronze.
2. All exterior aluminum windows shall be Bronze.
3. All interior metal door frames shall be painted, PS-4, Paint Color – P2.
4. All interior metal relite frames shall be painted, PS-4, Paint Color – TBD.
5. All interior wood doors shall be factory finished, stain color – Cane 45-97.
6. All hollow steel doors shall be painted, PS-2, Paint Color – TBD.
7. All mechanical grilles in walls and ceilings shall be painted the background colors of the material they are on. If grilles land in other materials (i.e. acoustic fiberboard panels, etc.) match the color.
8. See Painting Section of the Project Manual for Paint Systems (PS-1, etc).

Finish Abbreviations

Flooring

CPT1, CPT2, CPT3	Carpets – O.F.O.I.
SF1, SF2, SF3	Sport Flooring – O.F.O.I.
STF	Seamless Troweled Flooring
SDT	Static Dissipative Tile
VCT1	Vinyl Composition Tile, field.
VCT2 – VCT6	Vinyl Composition Tile, accents.
STR	Rubber Stair Treads and Risers

Base

RB1	Rubber Wall Base, 4” coved
RB2	Rubber Wall Base, 6” coved

Walls

P1 – P8	Paint Colors, see schedule below.
FRP	Fiber Glass Reinforced Panels
AWP2, 3, 4, 5, 6	Acoustic Wall Panel fabrics

Ceilings

ACT1, ACT2, ACT3	Acoustic Ceiling Tiles
AFB	Acoustic Fiber Board Panels (Inc. walls)

Cabinets

PL1, 2, 3, 4 5, 6, 7, 8, 9	Plastic Laminates
TDO	Thermoset Decorative Overlay.

Paint Colors

Paint Color - P1
Manufacturer: Pittsburgh Paints
Color: Ostrich Feather 413-3

Paint Color - P2
Manufacturer: Pittsburgh Paints
Color: Patches B-167

Paint Color - P3
Manufacturer: Pittsburgh Paints
Color: Honey Graham 324-5

Paint Color - P4
Manufacturer: Pittsburgh Paints
Color: Cavern Moss 409-5

Paint Color - P5
Manufacturer: Pittsburgh Paints
Color: Serene Stream 551-5

Paint Color - P6
Manufacturer: Pittsburgh Paints
Color: Smokey Grape 443-5

Paint Color - P7
Manufacturer: Pittsburgh Paints
Color: French Cream 415-1

Paint Color – P8
Manufacturer: Pittsburgh Paints
Color: Stony Creek 414-5

Paint Color – P9
Manufacturer: Pittsburgh Paints
Color: Armory 517-6

Room Name and Number: Airlock 101

SURFACE	MATERIAL	FINISH OR PAINT SYSTEM	PAINT COLORS NOTES
Floor	Concrete	Entry Mat	
Base	Wood	PS-10	
Walls	Gypsum Board	PS-5	P1
Ceiling	Gypsum Board	PS-5	P7

Room Name and Number: Lobby 102

SURFACE	MATERIAL	FINISH OR PAINT SYSTEM	PAINT COLORS NOTES
Floor	Concrete	VCT1,2,3,4,5,6	
Base	Wood / Rubber	PS-10 / RB1	
Walls	Gypsum Board	PS-5	P1
Ceiling	Gypsum Board/ Acoustic tile	PS-5 ACT-2	P7

Room Name and Number: Reception 103

SURFACE	MATERIAL	FINISH OR PAINT SYSTEM	PAINT COLORS NOTES
Floor	Concrete	CPT1	
Base	Wood	PS-10	
Walls	Gypsum Board	PS-5	P1
Wainscot	Wood	PS-10	
Ceiling	Gypsum Board/ Acoustic Tile	PS-5 Factory ACT-2	P2
Ceiling Soffit	Gypsum Board	PS-5	P2
Counter & Splashes	Plastic Laminate	PL8	
Recept. Desk Trans. Top	Plastic Laminate	PL9	
Recept. Desk Front/Approach Side	Wood	PS-10	
Mobile File Fronts	Plastic Laminate	PL7	

Room Name and Number: Corridor 106, 107, 117, 120, 125, 131, 136

SURFACE	MATERIAL	FINISH OR PAINT SYSTEM	PAINT COLORS NOTES
Floor	Concrete	VCT1,2,3,4,5,6	
Base	Rubber	RB1	
Walls	Gypsum Board	PS-5	P1
Walls	CMU	PS-7	P1
Walls	Vinyl Tack Panels	Factory	
Ceiling	Gypsum Board	PS-5	P7
	Acoustic Tile	ACT1	
Window Sills	Wood	PS-9	TBD
Ceiling Accent at Wing A	Gypsum Board	PS-5	P4
Ceiling Accent at Wing B	Gypsum Board	PS-5	P5
Ceiling Accent at Wing C	Gypsum Board	PS-5	P3
Ceiling Accent at Wing D	Gypsum Board	PS-5	P6

Room Name and Number: Principal 104

SURFACE	MATERIAL	FINISH OR PAINT SYSTEM	PAINT COLORS NOTES
Floor	Concrete	CPT1	
Base	Rubber	RB1	
Walls	Gypsum Board	PS-5	P1
Ceiling	Acoustic Tile	ACT2	
Counter & Splashes	Plastic Laminate	PL7	
Cabinets, Doors/Drawers	Plastic Laminate	PL8	
Tackboard	Vinyl	Factory	

Room Name and Number: Conference 105

SURFACE	MATERIAL	FINISH OR PAINT SYSTEM	PAINT COLORS NOTES
Floor	Concrete	CPT1	
Base	Rubber	RB1	
Walls	Gypsum Board	PS-5	P1
Ceiling	Acoustic Tile	ACT2	
Counter & Splashes	Plastic Laminate	PL8	
Cabinets, Doors/Drawers	Plastic Laminate	PL7	

Room Name and Number: Hall 108, Speech 109, Office 113, 116

SURFACE	MATERIAL	FINISH OR PAINT SYSTEM	PAINT COLORS NOTES
Floor	Concrete	CPT1	
Base	Rubber	RB1	
Walls	Gypsum Board	PS-5	P1
Ceiling	Acoustic Tile	ACT1	

Room Name and Number: Storage 110

SURFACE	MATERIAL	FINISH OR PAINT SYSTEM	PAINT COLORS NOTES
Floor	Concrete	VCT1	
Base	Rubber	RB1	
Walls	Gypsum Board	PS-5	P1
Ceiling	Acoustic Tile	ACT1	
Shelving	TDO	Factory, White	

Room Name and Number: Staff RR 111, 133, 134, Restroom 114

SURFACE	MATERIAL	FINISH OR PAINT SYSTEM	PAINT COLORS NOTES
Floor	Concrete	Sheet Vinyl	
Base	Rubber	RB2	
Walls	Gypsum Board	PS-6	P1
Ceiling	Gypsum Board	PS-6	P7

Room Name and Number: Files / Copy 112

SURFACE	MATERIAL	FINISH OR PAINT SYSTEM	PAINT COLORS NOTES
Floor	Concrete	CPT1	
Base	Rubber	RB1	
Walls	Gypsum Board	PS-5	P1
Ceiling	Gypsum Board/ Acoustic tile	PS-5 ACT2	P7
Counter & Splashes	Plastic Laminate	PL9	
Cabinets, Doors/Drawers	Plastic Laminate	PL8	

Room Name and Number: Restroom 114

SURFACE	MATERIAL	FINISH OR PAINT SYSTEM	PAINT COLORS NOTES
Floor	Concrete	Sheet Vinyl	
Base	Rubber	RB2	
Walls	Gypsum Board	PS-6	P1
Ceiling	Gypsum Board	PS-6	P7
Vanity Counter & Splashes	Plastic Laminate	PL8	
Vanity Skirt	Plastic Laminate	PL1	
Storage Cabinet	Plastic Laminate	PL1	

Room Name and Number: Staff Lounge 118, Work Room 119

SURFACE	MATERIAL	FINISH OR PAINT SYSTEM	PAINT COLORS NOTES
Floor	Concrete	VCT1	
Base	Rubber	RB1	
Walls	Gypsum Board	PS-5	P1
Ceiling	Acoustic Tile	ACT1	
Counter & Splashes	Plastic Laminate	PL1	
Cabinets, Doors/Drawers	Plastic Laminate	PL2	
Tackboard	Vinyl	Factory	
Mail box cabinet	Vinyl Tack Panels	Factory	

Room Name and Number: Health 115

SURFACE	MATERIAL	FINISH OR PAINT SYSTEM	PAINT COLORS NOTES
Floor	Concrete	Sheet Vinyl	
Base	Rubber	RB2	
Walls	Gypsum Board	PS-5	P1
Ceiling	Acoustic Tile	ACT1	
Counter & Splashes	Plastic Laminate	PL1	
Cabinets, Doors/Drawers	Plastic Laminate	PL2	

Room Name and Number: Stair 121

SURFACE	MATERIAL	FINISH OR PAINT SYSTEM	PAINT COLORS NOTES
Floor	Wood	STR	
Base	Rubber	Stair Skirting	
Walls	Gypsum Board	PS-5	P1
Ceiling	Gypsum Board	PS-5	P1
Stair Handrail	Metal	PS-3	TBD

Room Name and Number: Book Room 122, Computer Lab 123

SURFACE	MATERIAL	FINISH OR PAINT SYSTEM	PAINT COLORS NOTES
Floor	Concrete	CPT2	
Base	Rubber	RB1	
Walls	Gypsum Board	PS-5	P1
Ceiling	Acoustic Tile	ACT1	
Counter & Splashes	Plastic Laminate	PL1	
Cabinets, Doors/Drawers	Plastic Laminate	PL2	

Room Name and Number: Media Center 124

SURFACE	MATERIAL	FINISH OR PAINT SYSTEM	PAINT COLORS NOTES
Floor	Concrete	CPT2 & 3	Inset CPT3 within CPT2
Base	Rubber	RB1	
Walls	Gypsum Board	PS-5	P1
Walls	Vinyl Tack Panels		
Ceiling	Acoustic Tile	ACT2	
Ceiling	Gypsum Board	PS-5	P7
Soffits	Gypsum Board	PS-5	TBD
Counter & Splashes	Plastic Laminate	PL1	
Desk Front, Approach Side	Plastic Laminate	PL5	
Shelving	Plastic Laminate	PL7	All surfaces

Room Name and Number: Kitchen 126, Dry Storage/Office 127, Washing 128

SURFACE	MATERIAL	FINISH OR PAINT SYSTEM	PAINT COLORS NOTES
Floor	Concrete	STF	
Base	STF	Cove to 6” AFF	
Walls	Gypsum Board	FRP	
Walls	CMU	FRP	
Ceiling	Acoustic Tile	ACT3	
Counters	Stainless	Factory	
Cabinets, Doors/Drawers	Stainless Steel / Plastic Laminate	Factory, Architect to select from full color range	
Coiling Shutter	Stainless Steel	Factory	
Coiling Door Surround	Stainless Steel	Factory	Head, jamb and sill pieces

Room Name and Number: Serving 126A

SURFACE	MATERIAL	FINISH OR PAINT SYSTEM	PAINT COLORS NOTES
Floor	Concrete	STF & SF	Floor Transition to be at approach side of toe kick at cabinet
Base	Rubber	RB2	
Walls	Gypsum Board	FRP	
Ceiling	Acoustic Tile	ACT3	
Counters	Stainless	Factory, Architect to select from full color range	
Cabinets, Doors/Drawers	Plastic Laminate	Factory, Architect to select from full color range	
Approach Side of Cabinets	Plastic Laminate	Factory, Architect to select from full color range or PL6	
Coiling Door	Stainless Steel	Factory	
Coiling Door Frame	Hollow Steel	PS-4	TBD

Room Name and Number: Table Storage 129, Chair Storage 141

SURFACE	MATERIAL	FINISH OR PAINT SYSTEM	PAINT COLORS NOTES
Floor	Concrete	Sealed	
Base	Rubber	RB2	
Walls	Gypsum Board	PS-5	P1
Ceiling	Gypsum Board	PS-5	P1
Bumper Rail	Wood	No finish	

Room Name and Number: Custodian 130, 135

SURFACE	MATERIAL	FINISH OR PAINT SYSTEM	PAINT COLORS NOTES
Floor	Concrete	Sealed	
Base	Rubber	RB2	
Walls	Gypsum Board	PS-5	P1
Ceiling	Gypsum Board	PS-5	P1
Walls at Mop Sink	Gypsum Board	FRP	4'-0" AFF, Color matching top/bottom/vertical trims
Shelving	TDO	Factory, White	

Room Name and Number: Lunch 132

SURFACE	MATERIAL	FINISH OR PAINT SYSTEM	PAINT COLORS NOTES
Floor	Concrete	SF2 & 3	
Base	Rubber	RB2	
Walls	CMU	PS-7	P1
Ceiling	Acoustic Tile	ACT1	
Ceiling Soffit	Gypsum Board	PS-5	P7
Curtain (Alternate Bid)	Cotton Velour	Factory, Architect to select from full color range	

Room Name and Number: Multi-Purpose 137

SURFACE	MATERIAL	FINISH OR PAINT SYSTEM	PAINT COLORS NOTES
Floor	Concrete	SF1	
Base	Rubber	RB2	
Walls	CMU	PS-7	P1 Up to bottom of trusses P2 From trusses to ceiling
Soffits (at Steel Girder)	Gypsum Board	PS-5	P1
Walls	AFB	Factory	Natural
Wall Pads	Factory		TBD
Trusses	Steel	PS-3	TBD
Exposed ductwork	Metal	PS-4	TBD
Exposed brackets and electrical conduits	Metal	PS-4	TBD
Roof joists and sheathing	Wood	PS-5	TBD
Ceiling	AFB	Factory	Natural

Room Name and Number: Airlock 138, 144, 148

SURFACE	MATERIAL	FINISH OR PAINT SYSTEM	PAINT COLORS NOTES
Floor	Concrete	Entry Mat	
Base	Rubber	RB1	
Walls	CMU	PS-7	P1
Walls	Gypsum Board	PS-5	P1
Ceiling	Gypsum Board	PS-5	P7

Room Name and Number: Custodian 139

SURFACE	MATERIAL	FINISH OR PAINT SYSTEM	PAINT COLORS NOTES
Floor	Concrete	Sealed	
Base	Rubber	RB2	
Walls	CMU	PS-7	P1
Ceiling	Gypsum Board	PS-5	P1
Counter & Splashes	Plastic Laminate	PL1	
Cabinets, Doors/Drawers	Plastic Laminate	PL5	

Room Name and Number: Boiler 140, Electrical Room 143

SURFACE	MATERIAL	FINISH OR PAINT SYSTEM	PAINT COLORS NOTES
Floor	Concrete	Sealed	
Base	Rubber	RB2	
Walls	CMU	PS-8	P1
Ceiling	Gypsum Board	PS-5	P1

Room Name and Number: Office 142

SURFACE	MATERIAL	FINISH OR PAINT SYSTEM	PAINT COLORS NOTES
Floor	Concrete	VCT1	
Base	Rubber	RB2	
Walls	CMU	PS-7	P1
Ceiling	Gypsum Board	PS-5	P7

Room Name and Number: P.E. Equipment 147

SURFACE	MATERIAL	FINISH OR PAINT SYSTEM	PAINT COLORS NOTES
Floor	Concrete	Sealed	
Base	Rubber	RB2	
Walls	CMU	PS-8	P1
Ceiling	Gypsum Board	PS-5	P1
Cabinets	Plastic Laminate	PL1	

Room Name and Number: Alcove 150

SURFACE	MATERIAL	FINISH OR PAINT SYSTEM	PAINT COLORS NOTES
Floor	Concrete	SF1	
Base	Rubber	RB2	
Walls	CMU	PS-8	P1
Ceiling	Gypsum Board	PS-5	P7

Room Name and Number: Men 145, Women 146

SURFACE	MATERIAL	FINISH OR PAINT SYSTEM	PAINT COLORS NOTES
Floor	Concrete	Sealed	
Base	Rubber	RB2	Base shall be set in a continuous bead of sealant at the bottom prior to install.
Walls	CMU	PS-8	TBD
Ceiling	Gypsum Board	PS-6	TBD
Countertops	Plastic Laminate	TBD	
Toilet Partitions	Plastic Laminate	TBD	
Mirrors	Factory		
Accessories	Stainless Steel	Factory	

Room Name and Number: Stair 149

SURFACE	MATERIAL	FINISH OR PAINT SYSTEM	PAINT COLORS NOTES
Floor	Wood	STR	
Base	Rubber	Stair Skirting	
Walls	CMU	PS-7	P1
Ceiling	Gypsum Board	PS-5	P1
Stair Handrail	Metal	PS-3	TBD
Stair Railing Cap	Wood	PS-5	TBD

Room Name and Number: Classroom A1, A2, A3, A4, A5, A6, B1, B2, B3, B4, B5, B6, C1, C2, C3, C4, C5, C6, D1, D2, D3, D4, Alternate Bid Classroom D5, D6

SURFACE	MATERIAL	FINISH OR PAINT SYSTEM	PAINT COLORS NOTES
Floor	Concrete	CPT2	
Base	Rubber	RB1	
Walls	Gypsum Board	PS-5	P1
Ceiling	Acoustic Tile	ACT1	
Cabinets – Wings A, B,C, D.	Plastic Laminate	PL2	
Countertops – Wings A, B,C, D.	Plastic Laminate	PL1	
Open Adj. shelving – All wings.	Plastic Laminate	PL2	
Backsplash – Wing A	Plastic Laminate	PL4	
Backsplash – Wing B	Plastic Laminate	PL5	
Backsplash – Wing C	Plastic Laminate	PL3	Install grain of pattern horizontally
Backsplash – Wing D	Plastic Laminate	PL6	Install grain of pattern horizontally
Tackboards	Vinyl	Factory	
Markerboards	Steel	White	
Window Sills	Wood	PS-9	TBD

Room Name and Number: Girls A7, B7, C7, D7

SURFACE	MATERIAL	FINISH OR PAINT SYSTEM	PAINT COLORS NOTES
Floor	Concrete	Sealed	
Base	Rubber	RB2	Base shall be set in a continuous bead of sealant at the bottom prior to install.
Walls	CMU	PS-8	P1
Ceiling	Gypsum Board	PS-6	P7
Vanity Counter & Splashes	Plastic Laminate	PL8	
Vanity Skirt	Plastic Laminate	PL1	
Toilet Partitions	Plastic Laminate	TBD	

Mirrors	Factory		
Accessories	Stainless Steel	Factory	

Room Name and Number: Boys A8, B8, C8, D8

SURFACE	MATERIAL	FINISH OR PAINT SYSTEM	PAINT COLORS NOTES
Floor	Concrete	Sealed	
Base	Rubber	RB2 Base shall be set in a continuous bead of sealant at the bottom prior to install.	
Walls	CMU	PS-8	P1
Ceiling	Gypsum Board	PS-6	P7
Vanity Counter & Splashes	Plastic Laminate	PL8	
Vanity Skirt	Plastic Laminate	PL1	
Toilet Partitions	Plastic Laminate	TBD	
Mirrors	Factory		
Accessories	Stainless Steel	Factory	

Room Name and Number: Office A9, B9, C9

SURFACE	MATERIAL	FINISH OR PAINT SYSTEM	PAINT COLORS NOTES
Floor	Concrete	CPT2	
Base	Rubber	RB1	
Walls	Gypsum Board	PS-5	P1
Ceiling	Acoustic Tile	ACT1	

Room Name and Number: Shower D9

SURFACE	MATERIAL	FINISH OR PAINT SYSTEM	PAINT COLORS NOTES
Floor	Concrete	Sheet Vinyl	
Base	Rubber	RB2	
Walls	Gypsum Board	PS-6	P1
Ceiling	Gypsum Board	PS-6	P7
Vanity	Plastic Laminate	PL8	
Vanity Skirt	Plastic Laminate	PL1	
Bench Top & Splashes	Plastic Laminate	PL8	
Bench Base, Cubby	Plastic Laminate	PL1 All surfaces	
Shower	Fiberglass	Factory, White	
Shower Curtain	Fabric	White	
Accessories	Stainless Steel	Factory	

Room Name and Number: Office A10, B10, C10, Time Out D10

SURFACE	MATERIAL	FINISH OR PAINT SYSTEM	PAINT COLORS NOTES
Floor	Concrete	CPT1	
Floor to Mechanical	Concrete	Sealed	
Base	Rubber	RB1	
Walls	Gypsum Board	PS-5	P1
Walls	CMU	PS-7	P1
Ceiling	Acoustic Tile	ACT1	
Stairs and handrail	Metal	PS-3	P2

Room Name and Number: Ladder A10A, B10A, C10A, D10A

SURFACE	MATERIAL	FINISH OR PAINT SYSTEM	PAINT COLORS NOTES
Floor to Mechanical	Concrete	Sealed	
Base	Rubber	RB1	
Walls	Gypsum Board	PS-5	P1
Walls	CMU	PS-7	P1
Stairs and handrail	Metal	PS-3	P2

Room Name and Number: Hall A11, B11, C11, D11

SURFACE	MATERIAL	FINISH OR PAINT SYSTEM	PAINT COLORS NOTES
Floor	Concrete	VCT1	
Accent for All Wings		VCT2	
Accent for Wing A		VCT4	
Accent for Wing B		VCT5	
Accent for Wing C		VCT3	
Accent for Wing D		VCT6	
Base	Rubber	RB1	
Walls	CMU	PS-7	P1
Walls	Gypsum Board	PS-5	P1
Ceiling	Acoustic Tile/	ACT1	
	Gypsum Board	PS-5	P7
Cabinets	Plastic Laminate	TBD	

Room Name and Number: Break Out A12, B12, C12, D12

SURFACE	MATERIAL	FINISH OR PAINT SYSTEM	PAINT COLORS NOTES
Floor	Concrete	VCT1	
Accents in Wing A		VCT2, 4	
Accents in Wing B		VCT2, 5	
Accents in Wing C		VCT2, 3	
Accents in Wing D		VCT2, 6	
Base	Rubber	RB1	
Walls	CMU	PS-5	P1
Walls	Gypsum Board	PS-5	P1
	AWP2, 3, 4, 5, 6	Factory	
	Vinyl Tack Panels	Factory	
Ceiling	Gypsum Board	PS-5	P7
Skylight Frame	Metal	Bronze	
Skylight Panels	Translucent	White	
Bench & Shelf - Wing A	Plastic Laminate	PL4	
Bench & Shelf - Wing B	Plastic Laminate	PL5	
Bench & Shelf - Wing C	Plastic Laminate	PL3	
Bench & Shelf - Wing D	Plastic Laminate	PL6	
Shelf/Bench Vert. Supports- All Wings	P. Lam	PL7	
Back Wall Panel – All Wings	Plastic Laminate	PL7	
Bench Brackets Supports	Plastic Laminate	PL1	
Canopy Fascia/Trim	Wood	PS-5	TBD

Canopy Tops	Wood	PS-5	TBD
Canopy Ceilings	Gypsum Board	PS-5	TBD

Room Name and Number: Hall A13, B13, C13, Alternate Bid Hall D13

SURFACE	MATERIAL	FINISH OR PAINT SYSTEM	PAINT COLORS NOTES
Floor	Concrete	VCT1 / Entry Mat	
Accent for All Wings		VCT2	
Accent for Wing A		VCT4	
Accent for Wing B		VCT5	
Accent for Wing C		VCT3	
Accent for Wing D		VCT6	
Base	Rubber	RB1	
Walls	Gypsum Board	PS-5	P1
Ceiling	Gypsum Board/ Acoustic tile	PS-5 ACT-1	P7

Room Name and Number: Mechanical A20, B20, C20, D20,

SURFACE	MATERIAL	FINISH OR PAINT SYSTEM	PAINT COLORS NOTES
Floor	Self-level Under.	VCT1	
Base	Rubber	RB1	
Walls	Plywood	None	
Ceiling	Gypsum Board	None	

Room Name and Number: Mechanical 200, 202

SURFACE	MATERIAL	FINISH OR PAINT SYSTEM	PAINT COLORS NOTES
Floor	Concrete	Sealed	
Base	Rubber	RB1	
Walls	Plywood	None	
Ceiling	Gypsum Board	None	

Room Name and Number: MDF 201

SURFACE	MATERIAL	FINISH OR PAINT SYSTEM	PAINT COLORS NOTES
Floor	Concrete	SDT	
Base	Rubber	RB1	
Walls	Gypsum Board	PS-5	P1
Ceiling	Gypsum Board	PS-5	P1

Room Name and Number: Mechanical 203

SURFACE	MATERIAL	FINISH OR PAINT SYSTEM	PAINT COLORS NOTES
Floor	Self-level Under.	VCT1	
Base	Rubber	RB1	
Walls	Gypsum Board	None	
Walls	CMU	None	
Ceiling	Gypsum Board	None	

Room Name and Number: IDF 204

SURFACE	MATERIAL	FINISH OR PAINT SYSTEM	PAINT COLORS NOTES
Floor	Self-level Under.	SDT	
Base	Rubber	RB1	
Walls	Gypsum Board	PS-5	P1
Ceiling	Gypsum Board	PS-5	P1

END OF INTERIOR FINISH AND COLOR SCHEDULE

DOOR NO.	DOOR TYPE	DOOR SIZE	FRAME TYPE	HDWR GROUP	NOTES
101A	1	PR 3'-0" X 7'-0"	A1	1	Exterior Door
101B	1	PR 3'-0" X 7'-0"	A1	1	Exterior Door
101C	11	PR 3'-0" X 7'-0"	B1	2	
101D	11	PR 3'-0" X 7'-0"	B1	2	
103A	4	PR 3'-0" X 7'-0"	B2	3	
104A	5	3'-0" X 7'-0"	B5	4	
104B	6	2'-0" X 7'-0"	B5	5	
105A	5	3'-0" X 7'-0"	B5	4	
105B	5	3'-0" X 7'-0"	B3	6	
107A	2	3'-0" X 6'-8"	A2	7	Exterior Door
108A	5	3'-0" X 7'-0"	B5	6	
109A	5	3'-0" X 7'-0"	B5	6	
109B	5	3'-0" X 7'-0"	B5	4	
110A	6	3'-0" X 7'-0"	B5	4	
111A	6	3'-0" X 7'-0"	B5	8	
112A	5	3'-0" X 7'-0"	B5	6	
113A	5	3'-0" X 7'-0"	B3	4	
114A	6	3'-0" X 7'-0"	B5	8	
115A	5	3'-0" X 7'-0"	B5	4	
116A	5	3'-0" X 7'-0"	B5	4	
118A	5	3'-0" X 7'-0"	B5	5	
119A	5	3'-0" X 7'-0"	B5	5	
119B	5	3'-0" X 7'-0"	B5	6	
120A	2	3'-0" X 6'-8"	A2	7	Exterior door
121A	6	3'-0" X 7'-0"	B5	20	

DOOR NO.	DOOR TYPE	DOOR SIZE	FRAME TYPE	HDWR GROUP	NOTES
122A	5	3'-0" X 7'-0"	B5	4	
123A	5	3'-0" X 7'-0"	B5	4	
123B	5	3'-0" X 7'-0"	B5	6	
124A	5	3'-0" X 7'-0"	B4	9	
124B	5	3'-0" X 7'-0"	B4	9	
126A	7	4'-0" X 7'-0"	B9	10	90 minute fire rated
126B	5	3'-0" X 7'-0"	B9	6	
126C	12	16'-2" X 8'-0"	B10	Factory	Overhead Coiling Door
127A	5	3'-0" X 7'-0"	B5	20	
128A	13	3'-0" X 3'-0"	D1	Factory	Coiling Shutter
129A	8	PR 3'-0" X 7'-0"	B6	11	
130A	6	3'-0" X 7'-0"	B9	12	
131A	2	3'-0" X 6'-8"	A2	7	Exterior Door
131B	8	PR 4'-0" X 8'-0"	B6	13	90 minute fire rated, Mag hold open
131C	10	PR 3'-0" X 7'-0"	B8	14	
132A	3	PR 3'-0" X 7'-0"	B6	3	
132B	3	PR 3'-0" X 7'-0"	B6	3	
133A	6	3'-0" X 7'-0"	B9	15	
134A	6	3'-0" X 7'-0"	B9	15	
135A	6	3'-0" X 7'-0"	B9	12	
136A	2	3'-0" X 6'-8"	A2	7	Exterior Door
136B	8	PR 4'-0" X 8'-0"	B6	13	90 minute fire rated, Mag hold open
136C	10	PR 3'-0" X 7'-0"	B8	14	
138A	10	PR 3'-6" X 7'-0"	B8	16	Exterior Door
139A	6	4'-0" X 7'-0"	B9	17	

DOOR NO.	DOOR TYPE	DOOR SIZE	FRAME TYPE	HDWR GROUP	NOTES
139B	8	PR 3'-0" X 7'-0"	B6	18	Exterior Door
140A	9	4'-0" X 7'-0"	B9	19	Exterior Door
140B	9	3'-0" X 7'-0"	B9	20	60 Min. rated door
141A	9	4'-0" X 7'-0"	B9	17	
142A	5	3'-0" X 7'-0"	B9	20	
143A	9	4'-0" X 7'-0"	B9	19	Exterior Door
143B	9	2'-6" X 7'-0"	B9	21	60 Min. rated door.
144A	10	PR 4'-0" X 7'-0"	B7	16	Exterior Door
145A	6	3'-0" X 7'-0"	B9	22	
146A	6	3'-0" X 7'-0"	B9	22	
147A	6	4'-0" X 7'-0"	B9	17	
148A	10	PR 3'-0" X 7'-0"	B8	16	Exterior Door
149A	9	3'-6" X 7'-0"	B9	19	Exterior Door
150A	10	PR 4'-0" X 7'-0"	B7	23	
200A	6	3'-0" X 7'-0"	B5	5	
201A	6	3'-0" X 7'-0"	B5	5	
202A	6	3'-0" X 7'-0"	B5	6	90 minute fire rated
203A	6	3'-0" X 7'-0"	B5	5	
204A	6	3'-0" X 7'-0"	B5	5	

DOOR NO.	DOOR TYPE	DOOR SIZE	FRAME TYPE	HDWR GROUP	NOTES
A1A, B1A, C1A	5	3'-0" X 7'-0"	B11	4	
A1B, B1B, C1B	5	3'-0" X 7'-0"	B5	5	
A2A, B2A, C2A	5	3'-0" X 7'-0"	B11 SIM.	4	
A2B, B2B, C2B	5	3'-0" X 7'-0"	B5	5	
A3A, B3A, C3A	5	3'-0" X 7'-0"	B11	4	
A3B, B3B, C3B	5	3'-0" X 7'-0"	B5	5	
A4A, B4A, C4A	5	3'-0" X 7'-0"	B11	4	
A4B, B4B, C4B	5	3'-0" X 7'-0"	B5	5	
A5A, B5A, C5A	5	3'-0" X 7'-0"	B11	4	
A6A, B6A, C6A	5	3'-0" X 7'-0"	B11	4	
A9A, B9A, C9A	5	3'-0" X 7'-0"	B5	4	
A10A, B10A, C10A	5	3'-0" X 7'-0"	B5	4	
A10B, B10B, C10B	6	2'-4" X 7'-0"	B5	5	
A13A, B13A, C13A	1	PR 3'-0" X 7'-0"	A3	24	
D1A	5	3'-0" X 7'-0"	B11	4	
D1B	5	3'-0" X 7'-0"	B5	5	
D2A	5	3'-0" X 7'-0"	B11 SIM.	4	
D2B	5	3'-0" X 7'-0"	B5	5	
D3A	5	3'-0" X 7'-0"	B11	4	
D4A	5	3'-0" X 7'-0"	B11	4	
D13A	1	PR 3'-0" X 7'-0"	A3	24	
D9A	6	3'-0" X 7'-0"	B5	8	
D10A	5	3'-0" X 7'-0"	B5	4	
D10B	6	2'-4" X 7'-0"	B5	5	
D3B	5	3'-0" X 7'-0"	B5	5	ALTERNATE BID
D4B	5	3'-0" X 7'-0"	B5	5	ALTERNATE BID

D5A	5	3'-0" X 7'-0"	B11	4	ALTERNATE BID
D6A	5	3'-0" X 7'-0"	B11	4	ALTERNATE BID

END OF SCHEDULE

SPECIFICATION FOR:

HILLSIDE ELEMENTARY SCHOOL
EAGLE POINT, OR

FINISH:

OIL RUBBED BRONZE US 10B

MANUFACTURERS SPECIFIED		APPROVED EQUAL
BUTTS	STANLEY	MCKINNEY – IVES
CONTINUOUS HINGES	PEMKO	IVES
LOCKS	SCHLAGE E-KEYWAY	NO SUB
PANICS	VON DUPRIN	NO SUB
CLOSERS	LCN	NO SUB
MULLIONS	VON DUPRIN	NO SUB
OVERHEAD STOPS	GLYNN JOHNSON	ABH
MAGNETIC HOLDER	RIXSON	LCN
FLUSHBOLTS	IVES	TRIMCO
KICKPLATES	TRIMCO	IVES
PUSH-PULLS	TRIMCO	IVES
STOPS	IVES	TRIMCO
THRESHOLD	PEMKO	NGP
SWEEPS	PEMKO	NGP
GASKET	STEELCRAFT	PEMKO

GROUP 1

DRS 101A, 101B

2 EA	CONTINUOUS HINGES DFM 83 SLF-HDI
1 EA	PANIC 99NL
1 EA	PANIC 99DT
1 EA	CYLINDER 20-757
1 EA	MULLION KR4954
2 EA	CLOSERS 4041
2 EA	WALLSTOPS WS407CCV
2 EA	KICKPLATES 10 X 2 LDW
1 EA	THRESHOLD 272D
2 EA	DOOR SWEEPS 315DN
1 EA	WEATHERSTIP BY DOOR MANUFACTURER
1 EA	WIRING DIAGRAM

GROUP 2

DRS 101C, 101D

6 EA	BUTTS FBB168 4.5 X 4.5
2 EA	PULLS 990DT
2 EA	RAILS 330
2 EA	CLOSERS 4041
2 EA	KICKPLATES 10 X 2 LDW

GROUP 3

DRS 103A, 132A, 132B

6 EA	BUTTS FBB168 4.5 X 4.5
1 EA	PANIC 99NL
1 EA	PANIC 99DT
1 EA	CYLINDER 20-057
1 EA	MULLION KR4954
1 EA	CYLINDER 20-001
2 EA	CLOSERS 4041 H
2 EA	KICKPLATES 10 X 2 LDW
2 EA	WALLSTOPS WS407CCV

GROUP 4

DRS 104A, 105A, 109B, 110A, 113A, 115A, 116A, 122A, 123A, A1A, A2A, A3A, A4A, A5A, A6A, A9A, A10A, B1A, B2A, B3A, B4A, B5A, B6A, B9A, B10A, C1A, C2A, C3A, C4A, C5A, C6A, C9A, C10A, D1A, D2A, D3A, D4A, D5A, D6A, D10A

3 EA	BUTTS FBB179 4.5 X 4.5
1 EA	LOCKSET ND70 RHO
1 EA	WALLSTOP WS407CCV

GROUP 5

DRS 104B, 118A, 119A, A1B, A2B, A3B, A4B, A10B, B1B, B2B, B3B, B4B, B10B, C1B, C2B, C3B, C4B, C10B, D1B, D2B, D3B, D4B, D10B, 200A, 201A, 203A, 204A

3 EA	BUTTS FBB179 4.5 X 4.5
1 EA	PASSAGE ND10 RHO
1 EA	WALLSTOP WS407CCV OR FLOORSTOP FS436

GROUP 6

DRS 105B, 108A, 109A, 112A, 119B, 123B, 126B, 202A

3 EA	BUTTS FBB179 4.5 X 4.5
1 EA	LOCKSET ND70 RHO
1 EA	CLOSER 4041
1 EA	KICKPLATE 10 X 2 LDW
1 EA	WALLSTOP WS407CCV
1 SET	GASKET PS074

GROUP 7

DRS 107A, 120A, 131A, 136A

1 EA	CONTINUOUS HINGE DFM 83 SLF-HDI
1 EA	PANIC 99NL
1 EA	CYLINDER 20-757
1 EA	CLOSER 4041
1 EA	WALLSTOP WS407CCV
1 EA	THRESHOLD 272D
1 EA	SWEEP 315DN
1 EA	WEATHERSTRIP BY DOOR MANUFACTURER
1 EA	DRIP CAP 345D

GROUP 8

DRS 111A, 114A, D9A

3 EA	BUTTS FBB179 4.5 X 4.5
1 EA	OCCUPIED INDICATOR L9486 X L583-375
1 EA	AUTO DOOR BOTTOM 412CRL
1 EA	WALLSTOP WS407CCV
1 SET	GASKET PS074

GROUP 9

DRS 124A, 124B

3 EA	BUTTS FBB179 4.5 X 4.5
1 EA	PANIC 99NL
1 EA	CYLINDER 20-057
1 EA	CLOSER 4041
1 EA	KICKPLATE 10 X 2 LDW
1 EA	WALLSTOP WS407CCV
1 SET	GASKET PS074

GROUP 10

DR 126A

3 EA	BUTTS FBB179 5 X 4.5
1 EA	LOCKSET ND70 RHO
1 EA	CLOSER 4041
1 EA	KICKPLATE 24 X 2 LDW
1 EA	WALLSTOP WS407CCV
1 SET	GASKET PS074

GROUP 11

DR 129A

6 EA	BUTTS FBB179 4.5 X 4.5
1 EA	LOCKSET ND70 RHO
1 EA	FLUSHBOLT 458 (TOP ONLY)
2 EA	WALLSTOPS WS407CCV

GROUP 12

DRS 130A, 135A

3 EA	BUTTS FBB179 4.5 X 4.5
1 EA	LOCKSET ND80 RHO
1 EA	KICKPLATE 24 X 2 LDW
1 EA	WALLSTOP WS407CCV

GROUP 13

DRS 131B, 136B

8 EA	BUTTS FBB179 4.5 X 4.5
2 EA	PANICS 99LF
2 EA	CYLINDERS 20-057
2 EA	CLOSERS 4041
2 EA	MAGNETIC HOLDERS FM998 WIRED TO FIRE ALARM
1 EA	MULLION KR9954
1 EA	CYLINDER 20-001
1 SET	GASKET PS074

GROUP 14

DRS 131C, 136C

6 EA	BUTTS FBB168 4.5 X 4.5
2 EA	PULLS 990DT
2 EA	RAILS 330
2 EA	CLOSERS 4041
2 EA	KICKPLATES 10 X 2 LDW
2 EA	WALLSTOPS WS407CCV

GROUP 15

DRS 133A, 134A

3 EA	BUTTS FBB179 4.5 X 4.5
1 EA	OCCUPANCY INDICATOR L9486 X L583-375
1 EA	CLOSER 4041
1 EA	KICKPLATE 10 X 2 LDW
1 EA	WALLSTOP WS407CCV
1 EA	AUTO DOOR BOTTOM 412DRL
1 SET	GASKET PS074

GROUP 16

DR 138A, 144A, 148A

2 EA	CONTINUOUS HINGES DFM 83 HDI
1 EA	PANIC 99NL
1 EA	PANIC 99DT
1 EA	CYLINDER 20-757
1 EA	MULLION KR4954
1 EA	CYLINDER 20-001
2 EA	CLOSERS 4041
2 EA	KICKPLATES 10 X 2 LDW
2 EA	WALLSTOPS WS407CCV
1 EA	THRESHOLD 272D
2 EA	SWEEPS 315DN
1 SET	GASKET PS074
1 EA	DRIP CAP 345D (DRS + 4”)

GROUP 17

DRS 139A, 141A, 147A

3 EA	BUTTS FBB179 5 X 4.5
1 EA	LOCKSET ND70 RHO
1 EA	WALLSTOP WS407CCV

GROUP 18

DRS 139B

2 EA	CONTINUOUS HINGES DFM 83 HDI
1 EA	PANIC 99NL
1 EA	PANIC 99DT
1 EA	CYLINDER 20-757
1 EA	MULLION KR4954
1 EA	CYLINDER 20-001
2 EA	CLOSERS 4041 H
1 EA	THRESHOLD 272D
2 EA	SWEEPS 315DN
1 SET	GASKET PS074
1 EA	DRIP CAP 345D (DRS + 4”)

GROUP 19

DRS 140A, 143A, 149A

1 EA	CONTINUOUS HINGE DFM 83 HDI
1 EA	PANIC 99NL
1 EA	CYLINDER 20-757
1 EA	CLOSER 4041 H
1 EA	THRESHOLD 272D
1 EA	SWEEP 315DN
1 SET	GASKET PS074
1 EA	DRIP CAP 345D (DR + 4”)

GROUP 20

DRS 121A, 127A, 140B, 142A

3 EA	BUTTS FBB179 4.5 X 4.5
1 EA	LOCKSET ND80 RHO
1 EA	CLOSER 4041
1 EA	KICKPLATE 10 X 2 LDW
1 EA	WALLSTOP WS407CCV
1 SET	GASKET PS074

GROUP 21

DR 143B

3 EA	BUTTS FBB179 4.5 X 4.5
1 EA	PANIC 99LF – BE
1 EA	CLOSER 4041
1 SET	GASKET PS074

GROUP 22

DRS 145A, 146A

3 EA	BUTTS FBB168 4.5 X 4.5
1 EA	DEADBOLT B663
1 EA	PUSH PLATE 1001-11
1 EA	PULL 1017-3
1 EA	CLOSER 4041
1 EA	KICKPLATE 10 X 2 LDW
1 EA	WALLSTOP WS407CCV

GROUP 23

DR 150A

6 EA	BUTTS FBB168 5 X 4.5
2 EA	PULLS 990DT
2 EA	RAILS 330
2 EA	CLOSERS 4041
2 EA	KICKPLATES 10 X 2 LDW
2 EA	WALLSTOPS WS407CCV

GROUP 24

DRS A13A, B13A, C13A, D13A

2 EA	CONTINUOUS HINGES DFM 83 SLF-HDI
1 EA	PANIC 99NL
1 EA	PANIC 99DT
1 EA	CYLINDER 20-757
1 EA	MULLION KR4954
1 EA	CYLINDER 20-001
2 EA	CLOSERS 4041
2 EA	WALLSTOPS WS407CCV
2 EA	KICKPLATES 10 X 2 LDW
1 EA	THRESHOLD 272D
2 EA	SWEEPS 315DN
1 EA	WEATHERSTRIP BY DOOR MANUFACTURER

GROUP 25

DRS A11A, B11A, C11A, D11A

6 EA	BUTTS FBB179 4.5 X 4.5
1 EA	PANIC 99NL
1 EA	PANIC 99DT
1 EA	CYLINDER 20-057
1 EA	MULLION KR4954
1 EA	CYLINDER 20-001
2 EA	MAGNETIC HOLDERS FM998